STATE OF ILLINOIS
STATE GEOLOGICAL SURVEY
FRANK W. DeWOLF, Director.

EXTRACT FROM BULLETIN 20

# The Carlyle Oil Field and Surrounding Territory

BY

E. W. SHAW

U. S. Geological Survey
In Cooperation with
State Geological Survey

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# The Carlinville Oil and Gas Field

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FRED H. KAY
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# THE CARLYLE OIL FIELD AND SURROUNDING TERRITORY.

## TABLE OF CONTENTS.

# LIST OF ILLUSTRATIONS.

## Plates.

# THE CARLYLE OIL FIELD AND SURROUNDING TERRITORY.

(By E. W. Shaw.)

U. S. Geological Survey, in cooperaton with State Geological Survey.

## INTRODUCTION.

The excitement attending the discovery of oil at Carlyle in the spring of 1911 was unusually intense. In a very short time, however, systematic development began and the field took its place among the producers of the State. As development progressed, it became evident that the productive area had been outlined more or less clearly and general interest shifted to the question of the existence of other oil pools in the vicinity.

This report attempts to point out certain areas where the geological structure is favorable for the accumulation of oil and gas in the region surrounding Carlyle.

### Area Treated in This Report.

The present report is preliminary and somewhat general. It treats not only the developed oil field northwest of Carlyle, but a large part of Clinton, Washington, and St. Clair counties, and also parts of Monroe and Madison counties (See Plate II).

This district is on the whole a flat prairie but there are numerous hills and valleys and considerable woods. The altitude ranges from less than 400 feet along some of the larger streams to about 600 at the tops of some of the hills in the central and northeastern parts, and 700 along the bluffs of Mississippi river. A large part of the surface lies between 460 and 480 feet above sea level. Kaskaskia river flows through the district from the northeast. receiving from the north the waters of Beaver, Shoal, Sugar, Silver, and Richland creeks, and from the south the waters in Crooked, Elkhorn, and Big Muddy creeks. The principal towns are Carlyle, Nashville, Okawville, Mascoutah, Trenton, Belleville, Freeburg, New Athens, and Marissa.

The basis of this report is a detailed survey of areas known as the Carlyle, Okawville, and New Athens quadrangles, made by the writer in the summer of 1911, together with observations in surrounding territory made in part by others in 1911 and preceding summers. The work was done under a coöperative agreement between the Illinois and the U. S. Geological Surveys. The material gathered by Professor J. A. Udden

in the Belleville and Breese quadrangles, by Professor Stuart Weller in the Waterloo and Kimmswick quadrangles, and by R. S. Blatchley in the Sandoval oil field[1] has been freely drawn upon. Thanks is due to the many oil operators, contractors, drillers, and others who freely gave information, and particularly to those who kept careful logs and made other observations especially for the Survey. To all these the writer gratefully acknowledges his indebtedness.

## Object and Methods of Work.

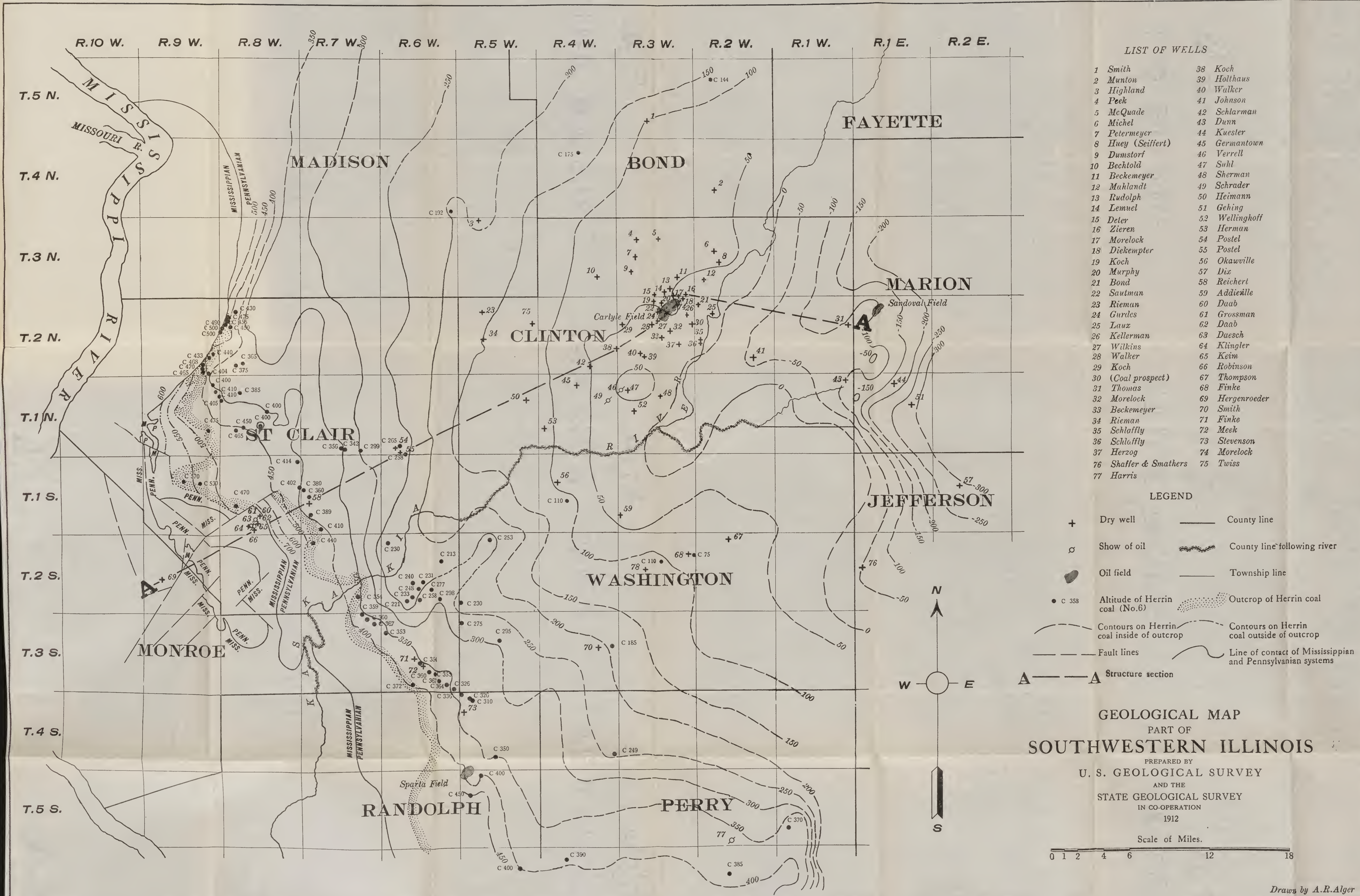
The investigation which is the basis of this report was not primarily a study of the oil and gas of the region, but was intended to cover all lines of geologic work. It included the study of coal, clay, gravel, limestone, sandstone, and other rocks. The results were in part of immediate value in the exploitation of the mineral resources of the region, and in part purely scientific, having only an indirect economic bearing. Most of the observations were made on outcrops, surface features, and wells in the process of being drilled, but much information was obtained in the form of records of wells drilled both during and before the summer of 1911. In the producing oil territory the writer was able to visit most of the wells several times during the course of drilling and thus obtain first-hand knowledge of many of the strata being passed through.

In this report the method of treatment will be first to describe the rocks of the entire region in general, and then those of the Carlyle oil field in particular, with the oil and gas that they contain.

## Oil and Gas Prospecting.

At first thought it would seem to be very difficult to work out the principles which govern the accumulation of oil and gas far below the surface. Indeed, after much careful observation many oil operators are only the more firmly convinced that no one before prospecting can tell anything about where these valuable resources exist. There is a common expression that "the drill only will tell the story." Many, if not most, men when they begin to study the problem try to find something of significance in surface features. One, from his more or less limited experience, will say that valley bottoms are the best places to prospect; another, having had experience in a different district, will say that hilltops are best, and a third conceives that a certain peculiar arrangement of hills and valleys is most favorable. The geologist in Illinois can see no connection between surface features and oil and gas pools except in the obscure way that the "lay" of the rocks has affected the surface relief. The bed rock in the Illinois oil fields is covered by a mantle of glacial drift, which commonly conceals the structure of the underlying strata.

[1] Blatchley, R. S., Illinois Oil Resources: Bull. Ill. State Geol. Survey No. 16, pp. 42-176.




Map of southwestern Illinois showing geologic structure and location of oil fields, wells, and coal prospects.

# GEOLOGY OF THE REGION.

## Stratigraphy.

Stratigraphy is a description of the layers of rock, including their order and relative positions. In Clinton, Washington, and St. Clair counties, and adjacent territory, all the known materials of the earth lying within three thousand or more feet from the surface are of sedimentary origin. They were once either in the form of particles, or else dissolved in water and they were all transported and deposited in their present position by water, or wind, or ice.

Most, if not all, of the limestones of the region were once limy muds such as are found on many parts of the ocean bottom today. In them were buried the shells of animals that lived in the sea at the time. The resulting layers of limestone with marine fossils show that in ages gone by southern Illinois lay beneath the sea.

The shales and clays were once ordinary muds—some of them deposited on the ocean bottom and some of them on land—for the region was not covered by sea water continuously. The marine mud consisted of fine sediment delivered to the sea by rivers from some land area and by waves which beat against the shore, just as sediment is being carried into the sea at the present time. In the sea water it slowly settled to the bottom, forming layers of more or less uniform thickness. The sea was then, as it is now, inhabited by animals and plants. Almost all of the plant and most of the animal matter decayed without leaving any impression on the bottom, but now and then conditions were such that hard parts, such as shells, when buried in the mud, left very definite impressions. We find these impressions or remains today and call them fossils.

Some of the shale and clay having no marine fossils may have been spread out on coastal plains a little above the level of the sea; some of it certainly was, for it contains impressions of land plants and animals.

The sandstone was once sand and was deposited in sea water, on land in lakes, or possibly by wind, for sand is carried and deposited in all of these ways; and since, as a rule, sand is poor material to receive and preserve impressions of plant and animal remains, and since other thoroughly reliable ways for distinguishing sea from land deposits have not yet been devised, it is not always possible to state what the origin of each of the sandstones has been.

Coal was formed in extensive marshes very near sea level. It consists of more or less disintegrated plant matter. Living plants are composed of water and many liquid and solid carbohydrates, resins, waxes, etc. Coal is made up of the same materials, except that most of the water and many of the products of the chemical transformation or decomposition of some of these materials, have been pressed out.

The rocks of the earth form naturally several systems, each of which represents a long period of time—several millions of years. Not all of these systems are represented in the region under discussion (See Plates III and IV). The oldest definitely known to be present is the Ordovician, but this is no doubt underlain by Cambrian and still older rocks.

The Silurian and Devonian, which lie above the Ordovician and elsewhere include strata thousands of feet in thickness, are thin in this area, and it is possible that the Silurian may be absent. Above the Devonian lies the Carboniferous system, which includes everything from the bottom of the Mississippian limestones to the uppermost hard rocks of the region. The age of the Carboniferous dates back about halfway in geologic time. Four systems above the Carboniferous are lacking and the only remaining one represented is the Quaternary to which belong the clay, sand, and gravel lying upon the shale, sandstone, and limestone of the Carboniferous system and forming the surface of all of this region.

The various layers of rock are described in order beginning at the bottom.

### ROCKS OLDER THAN CARBONIFEROUS.

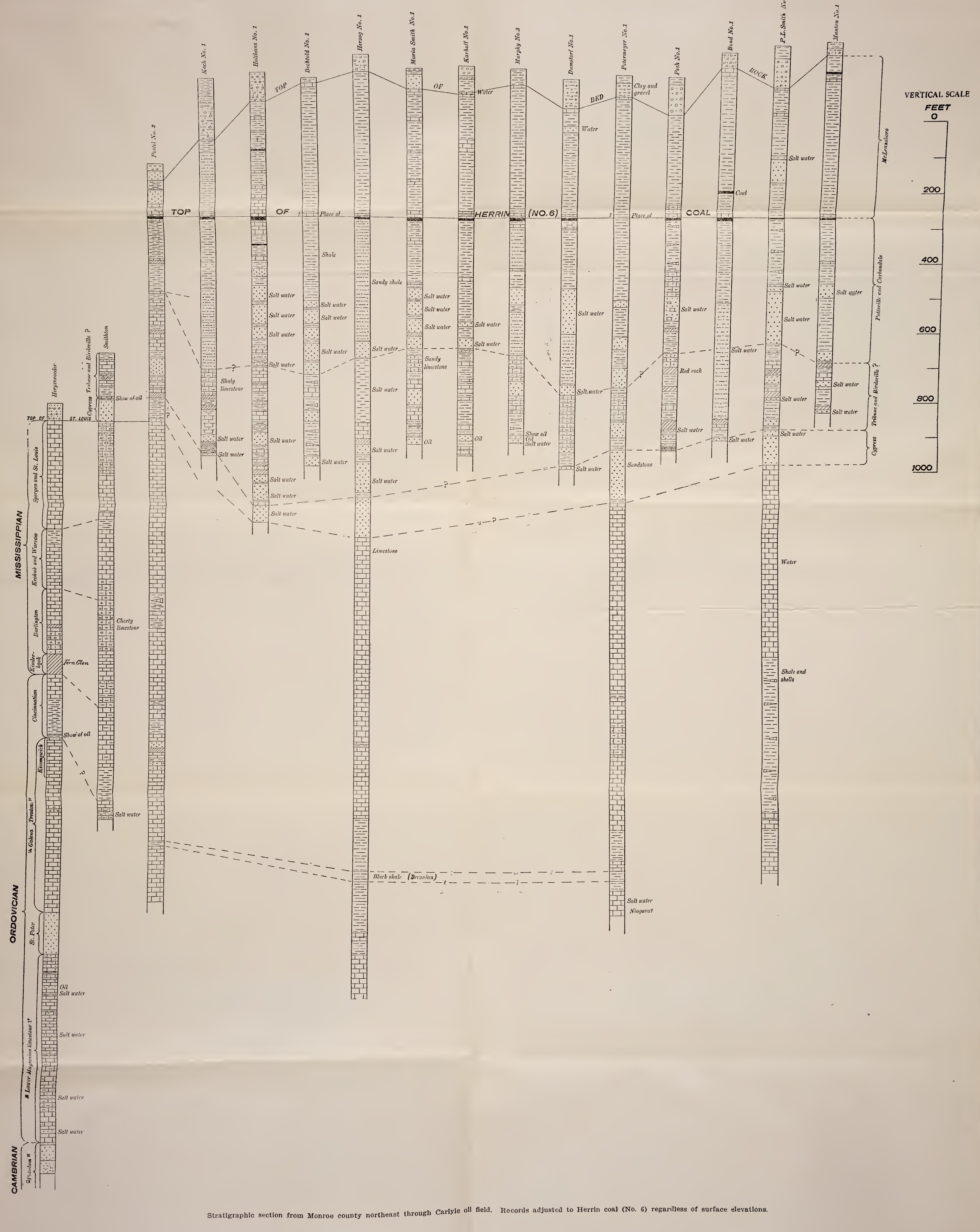
In the region under discussion the Cambrian system lies so far beneath the surface that it has not been reached by the deepest wells. Judging by its character in other areas where it is known, it is probably a great sandstone about a thousand feet thick which is called the "Potsdam." This rock is persistent and probably underlies all of southwestern Illinois.

The Ordovician system is presumably made up of four principal divisions. The lowermost one does not outcrop and has not been reached in any of the deep wells. It is a magnesian limestone probably over 400 feet thick and has been called the "Lower Magnesian limestone series" or Prairie du Chien group.

The second division is the St. Peter sandstone. To the north where the rock is well exposed it is 100 feet or more in thickness and consists of well rounded grains of sand.

Above the St. Peter is several hundred feet of rock which is predominantly dolomite, but includes some limestone and a little shale, particularly in the lowermost part. This rock is frequently referred to as the "Galena-Trenton" limestone because it seems to be, in part at least, equivalent to the Trenton limestone of New York and other states, and in part to the Galena dolomite of northwestern Illinois, the relations of these formations not yet having been satisfactorily worked out. The extract thickness of these rocks in Clinton, Washington, and St. Clair counties is not known. Only the uppermost part is exposed and that is in the river bluff at Valmeyer in Monroe county. It is possible that over 400 feet are assignable to this division of the Ordovician.

The next beds are of Cincinnatian (Upper Ordovician) age and are more or less shaly. These, like the underlying beds, have not yet been identified with certainty because the well records are not detailed enough to give identification characteristics; but the rocks are probably present under the entire district, and if specimens containing fossils could be obtained, identification would be easy.




Stratigraphic section from Monroe county northeast through Carlyle oil field. Records adjusted to Herrin coal (No. 6) regardless of surface elevations.

The Silurian system which includes the Niagara group (the basal formation of which, in New York and other eastern states is the Clinton) is probably thin, if present at all, in the area under consideration.

The Devonian system for the most part is also difficult to identify from ordinary well records, but a hard black shale belonging in the uppermost part of the Devonian seems to be the representative of the system. It is found in some of the deep borings, particularly those on the Petermeyer and Herzog farms near Carlyle, records of which are given below. Older Devonian strata probably underlie this shale and consist of limestone and sandstone as in Jackson and other counties.

The following records are of wells which have reached a part of the rocks described thus far (See also Plates III and IV).

*Well No. 1, on Hergenroeder farm.*

Location—Sec. 20, T. 2 S., R. 9 W.
Altitude—560 feet.

| | Thickness —feet: | Depth— feet. |
|---|---|---|
| Dark sand | 50 | 50 |
| Yellow lime | 320 | 370 |
| Dark shale | 45 | 415 |
| White lime | 130 | 545 |
| Gray lime | 70 | 615 |
| White lime | 35 | 650 |
| Red rock | 10 | 660 |
| Limestone | 10 | 670 |
| Flinty lime | 40 | 710 |
| Sandy lime | 25 | 735 |
| Red rock | 60 | 795 |
| White lime | 170 | 865 |
| White break shale | 105 | 970 |
| Sand (oil) | 2 | 972 |
| Shale | 8 | 980 |
| Gray lime | 15 | 995 |
| Limestone, soft | 100 | 1,095 |
| Brown lime, hard | 45 | 1,140 |
| Gray lime | 40 | 1,160 |
| White flinty lime | 20 | 1,200 |
| Gray lime | 20 | 1,220 |
| Dark lime | 40 | 1,260 |
| Gray lime | 60 | 1,320 |
| Light gray lime | 80 | 1,400 |
| Gray lime | 30 | 1,430 |
| Gray lime | 60 | 1,490 |
| Water sand | 15 | 1,505 |
| Sand | 107 | 1,612 |
| Sandy lime | 28 | 1,640 |
| White sandy lime | 10 | 1,650 |
| Limestone | 10 | 1,660 |
| Break, slate | 2 | 1,662 |
| White lime | 3 | 1,665 |
| Gray sandy lime | 3 | 1,668 |
| Sandy lime | 10 | 1,678 |
| White sand | 5 | 1,683 |
| White lime | 17 | 1,700 |
| Oil sand (oil) | 12 | 1,712 |
| White lime | 8 | 1,720 |
| Water sand | 5 | 1,725 |
| White slate | 5 | 1,730 |
| White lime | 40 | 1,770 |
| Break, slate | 5 | 1,775 |
| Sandy lime | 10 | 1,785 |
| Brown lime | 15 | 1,800 |
| White lime | 40 | 1,840 |
| White sand (some water) | 10 | 1,850 |

*Well No. 1 on Hergenroeder farm*—Concluded.

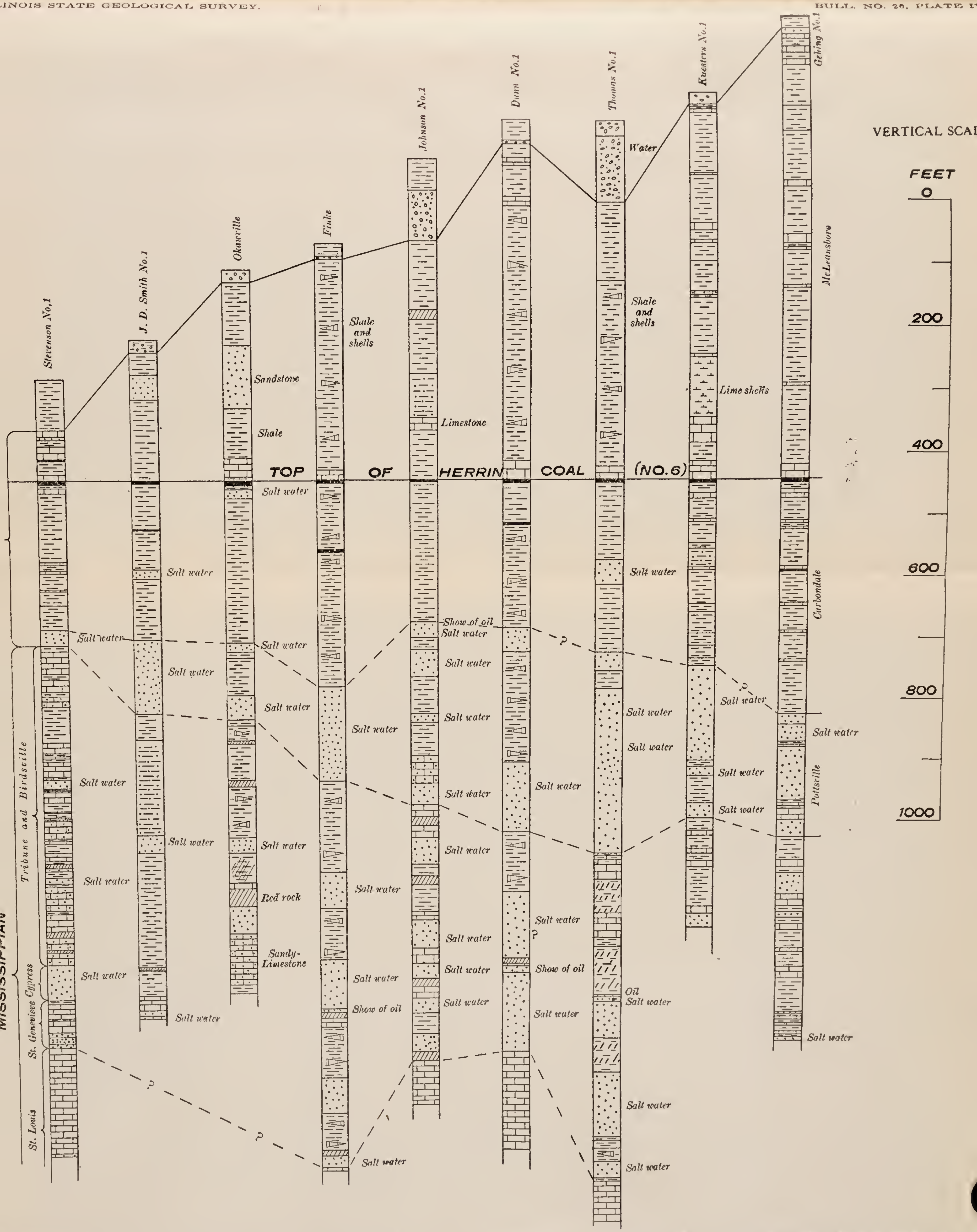
| | Thickness —feet. | Depth—feet. |
|---|---|---|
| White lime | 50 | 1,900 |
| Break, slate | 5 | 1,905 |
| White sand | 10 | 1,915 |
| White lime (mostly) | 85 | 2,000 |
| Coarse white broken lime | 10 | 2,010 |
| Sandy lime | 10 | 2,020 |
| Water sand, hard | 10 | 2,030 |
| Broken sandy lime | 40 | 2,070 |
| White lime | 30 | 2,100 |
| Sandy lime | 10 | 2,110 |
| Dark brown lime | 10 | 2,120 |
| White salt sand | 12 | 2,132 |
| White lime | 26 | 2,158 |
| Light brown sand | 7 | 2,165 |
| Light brown sand | 45 | 2,210 |
| Light brown sand | 38 | 2,248 |

*Well No. 1, P. H. Postel Milling Company.*[1]

Location—At Mascoutah, sec. 32, T. 1 N., R. 6 W.
Altitude—420 feet (estimated).

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Loess | 30 | 30 |
| Quicksand | 5 | 35 |
| Sand, white | 5 | 40 |
| Sand, gravel and other drift | 64 | 104 |
| Limestone | 8 | 112 |
| Shale, hard, coaly | 30 | 142 |
| Limestone | 3 | 145 |
| Coal (No. 6) | 6 | 151 |
| Shale | 15 | 166 |
| "Soapstone" | 10 | 176 |
| Shale | 25 | 201 |
| Coal | 5 | 206 |
| Shale, white | 50 | 256 |
| Shale, blue | 40 | 296 |
| Shale, white | 45 | 341 |
| Red rock | 45 | 386 |
| Shale | 35 | 421 |
| Shale "cave" | 113 | 544 |
| Limestone | 5 | 549 |
| Sandstone | 45 | 584 |
| Shale | 25 | 609 |
| Limestone | 20 | 629 |
| Red rock, probably a hard, calcareous shale | 55 | 684 |
| Shale, white | 20 | 704 |
| Sandstone (Benoist sand of drillers?) | 20 | 724 |
| Limestone | 460 | 1,184 |
| "Shale rock" | 420 | 1,604 |
| Limestone, shaly | 390 | 1,994 |
| Marl, red | 70 | 2,064 |
| Limestone | 126 | 2,190 |
| "Shale rock" | 127 | 2,317 |
| Limestone | 449 | 2,766 |
| "Shale rock" | 58 | 2,824 |
| Limestone | 10 | 2,834 |
| Shale and limestone | 54 | 2,888 |
| Sandstone and some shale | 219 | 3,107 |

[1] It is reported that 2 barrels of oil per day have been gotten at times from this well.




Stratigraphic section from Randolph county northeast into Marion county. Records adjusted to Herrin coal (No. 6) regardless of surface elevations.

### *Well on Petermeyer farm.*

Location—7 miles northwest of Carlyle, sec. 17, T. 3 N., R. 3 W.
Altitude—469 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Clay | 20 | 20 |
| Gravel, fine, well washed | 38 | 58 |
| "Limestone shells" | 6 | 64 |
| "Slate" | 561 | 625 |
| Sandstone | 20 | 645 |
| "Slate" | 83 | 728 |
| Sandstone | 37 | 765 |
| "Slate" | 55 | 820 |
| Sandstone | 56 | 876 |
| "Slate" | 14 | 890 |
| "Slate", broken | 80 | 970 |
| "Limestone shells" | 2 | 972 |
| (Show of oil and gas and hole full of salt water at 975 feet). | | |
| Sandstone | 48 | 1,020 |
| "Slate" | 36 | 1,056 |
| Sandstone | 144 | 1,200 |
| "Slate" | 10 | 1,210 |
| Limestone | 565 | 1,775 |
| "Slate" | 10 | 1,785 |
| Limestone | 75 | 1,860 |
| "Slate" and limestone | 100 | 1,960 |
| Limestone | 220 | 2,180 |
| "Slate" | 90 | 2,270 |
| Limestone | 30 | 2,300 |
| Shale ("pencil cave") | 30 | 2,330 |
| "Slate", black (Devonian?) | 28 | 2,358 |
| Limestone (salt water) | 72 | 2,430 |

### *Well on Philip Herzog farm.*

Location—1 mile southwest of Carlyle, sec. 23, T. 2 N., R. 3 W.
Altitude—467 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Clay and gravel | 46½ | 46½ |
| Shale and sandstone | 393½ | 440 |
| Limestone | 5 | 445 |
| Shale | 5 | 450 |
| Coal | 7 | 457 |
| Shale and sandstone | 343 | 800 |
| Sandstone (salt water) | 50 | 850 |
| "Slate" | 185 | 1,035 |
| Limestone | 45 | 1,080 |
| Red rock | 18 | 1,098 |
| Sandstone (salt water) | 30 | 1,128 |
| "Slate" | 20 | 1,148 |
| Sandstone (salt water) | 91 | 1,239 |
| "Slate" | 14 | 1,253 |
| Sandstone | 122 | 1,375 |
| Limestone | 610 | 1,985 |
| Shale | 8 | 1,993 |
| Limestone | 212 | 2,205 |
| Shale | 155 | 2,360 |
| Shale, black | 30 | 2,390 |
| Shale | 145 | 2,535 |
| Limestone "Niagara" | 25 | 2,560 |
| "Slate" | 40 | 2,600 |
| Limestone | 133 | 2,733 |

It will be seen that the above logs do not show great detail. Some of the measurements are doubtless in error, but it is believed that the records are sufficiently accurate to give a good general idea of the succession of rocks, especially when Plates III and IV are studied.

## CARBONIFEROUS SYSTEM.

### *Mississippian Series.*

The Mississippian series is better known than any of the older rocks, both because it outcrops extensively in southwestern St. Clair county and adjacent territory, and also because it has been penetrated by many wells. It consists of nine distinct divisions, many of which can be recognized in a good set of well drillings, and all except the Cypress sandstone, in which no fossils have yet been found, can be recognized from small pieces containing fossils.

The lowest beds are known by the name of Kinderhook, and are variable in thickness and character, but are probably nowhere over 200 feet thick. The next higher beds, which have received the name of Burlington limestone, consist of whitish, crystalline, more or less flinty limestone, about the same in thickness as the preceding. Overlying the Burlington is the Keokuk limestone, which is overlain by the Warsaw shale. The combined thickness of the Keokuk and Warsaw is 100 to 150 feet. The next division, the Spergen ("Salem") limestone, is light-colored and about a hundred feet thick. It is overlain by more than 200 feet of variable limestone, in some places shaly and in some places very cherty, but nowhere oolitic. This rock is known as the St. Louis limestone and is very much like the overlying Ste. Genevieve limestone, except that the latter is oolitic. The next division is the Cypress sandstone, which appears to be the Benoist sand of the drillers, the lowest thick persistent sandstone in the Mississippian series. This rock is about 100 feet thick, although it varies locally from 50 to as much as 200 feet. It is porous, loosely cemented, has few, if any, shale partings, and no fossils. It is overlain by a group of beds consisting of limestone, sandstone, and shale, which make up the Birdsville and Tribune formations.[1] These include the producing sand at Carlyle and several other sands. Near Chester these rocks have been described by Prof. Stuart Weller.[2] The total amount of limestone varies somewhat from place to place, but is nowhere more than two-thirds of the whole; in many places it constitutes less than one-third.

The following section represents the rocks exposed near Chester, where there appears to be more limestone in the Chester group than elsewhere:

---

[1] The Cypress standstone is included in the Chester group by the United States Geological Survey; and some geologists, including Ulrich, refer the underlying Ste. Genevieve limestone also to the same group. The Illinois Survey has used "Chester" for the beds now designated Birdsville and Tribune

[2] Weller, Stuart, The geological map of Illinois: Bull. Ill. State Geol. Survey No. 6, 1907.

*Section of rocks exposed near Chester, Illinois.*

| | Feet. |
|---|---|
| Birdsville formation— | |
| Sandstone at Rockwood | 100 |
| Limestone | 20 |
| Shale, arenaceous; or shaly sandstone | 47 |
| Sandstone | 10 |
| Shale, arenaceous; or shaly sandstone | 33 |
| Limestone | 54 |
| Shale | 42 |
| Limestone (persistent) | 8 |
| Shale | 36 |
| (In some places a bed of sandstone occurs here with variable thickness up to 20 feet.) | |
| Limestone | 4 |
| Shale | 4 |
| Tribune limestone— | |
| Limestone (quarried at the Penitentiary) | 80 |
| Interval of uncertain character, lower part probably shale and upper part limestone | 20 |
| Limestone | 49 |
| Probably mostly shale | 38 |
| Shale, variegated red and green | 15 |
| Not exposed | 5 |
| Limestone, fossiliferous; Shale, fossiliferous | 20 |
| Limestone, very fossilid, fossiliferous; Shale | 15 |
| Beds not observed | 25 |
| Cypress sandstone | 134 |

The Chester is the uppermost group of the Mississippian beds in this region. Some drillers have fallen into the habit of speaking of that part of the Mississippian series which lies below the Cypress sandstone as the "Mississippi lime." This expression is undesirable, for the Mississippian series includes all of the Chester as well as the limestone formations below.

## *Pennsylvanian Series.*

The Pennsylvanian series includes all the coal-bearing beds of Illinois, and is separated from the Mississippian by an unconformity which marks a time when Illinois became dry land and remained so for a long period. In many drill holes the unconformity is not noticeable, and even where the rocks actually outcrop it is in some places not easy to locate. The uppermost Mississippian rock commonly still shows the effect of its exposure to the weather millions of years ago, being soft and brownish. The lowermost Pennsylvanian rock consists generally of a layer of cemented pebbles which is sometimes noted in well logs. It is difficult to distinguish from higher beds in which there are scattered pebbles.

*Pottsville sandstone.*—The Pottsville sandstone is composed of sandstone and shale with local thin lenses of coal. It is commonly known in the Carlyle oil field as the "salt sand." Near St. Louis the Pottsville is locally less than 20 feet thick and consists largely of clay. To the east it thickens to about 160 feet at Carlyle, south of which it is probably still thicker for it thickens generally in that direction and reaches over 500 feet in Jackson county. It contains no limestone, but

is made up of several beds of sandstone separated by lenses of shale. Much of the sandstone is very porous but some is almost as impervious as shale.

*Carbondale formation.*—The Carbondale formation extends from the top of the Pottsville to the top of the Herrin coal (No. 6),[1] which is the main coal bed of the region. Usually another bed of coal, the Murphysboro (No. 2) is present, forming the base of the formation, and still another about equally persistent, lies almost exactly midway between the Murphysboro and Herrin coals, or about 125 feet below the latter. Still other coal beds are present in some places. Shale constitutes the major part of the formation but there is much sandstone, particularly in the lower half; and a few layers of limestone, particularly in the uppermost and lowermost parts. Much of the shale is soft and clay-like.

*McLeansboro formation.*—The McLeansboro formation extends from the top of the Herrin coal (No. 6) to the highest hard rocks of the region, or somewhat above the limestone upon which drive pipe is commonly set in the Carlyle oil field. The Herrin coal is generally overlain by shale up to 30 feet thick but locally this shale is absent and the overlying limestone rests directly on the coal. The limestone above the Herrin coal is even more persistent than the coal itself and may be used in an important way to determine the horizon of the coal where that bed is absent or questionable. The limestone contains a little fossil, scarcely as large as a grain of wheat, which can be identified even in the ground-up material from the drill hole. This limestone and the underlying coal are the most important key rocks in the region for they are persistent and easily recognized. Drillers should, therefore, make careful measurements to these beds so as to identify properly the sandstones of the Chester, some of which contain oil.

Above the limestone overlying the Herrin coal occurs more than 300 feet of clay, shale, and sandstone generally free from limestone. This series of beds extends up to the limestone which has been called Shoal Creek limestone in the Illinois State Survey reports, about 300 to 350 feet above the Herrin coal. The remaining beds of the McLeansboro formation are mostly soft shale and sandstone.

### QUATERNARY SYSTEM.

The Quaternary system includes the surface sand, clay, and gravel which, although it is many thousands of years old, does not average more than one-tenth as old as the rocks of the Carboniferous system. Much of this surface material is glacial. It was brought here by a great ice sheet that crept down from Canada bringing with it stones from that country very unlike the rocks of Illinois and leaving them spread over this region. Some of the rock and dirt was deposited directly by the ice and is a mass of clay (largely rock flour, ground by

[1] The custom of using place names instead of numbers to designate the age of coal beds is generally desirable. It should be remembered, however, that the coals vary greatly in commercial importance from place to place and that the use of the same geologic name for coals of various districts implies only contemporaneous deposition—in no sense uniform quality.—Editor.

the glacier), sand, and gravel thoroughly mixed together. There are also beds of sand and gravel which were deposited on or in front of the ice. Upon this gravelly clay there is generally a bed of clay without any grit which was probably deposited by wind. This clay covers the prairie and the hills and valley sides, but the valley bottoms have a more recent deposit laid down by the streams.

## SUMMARY OF GEOLOGIC HISTORY.

The history recorded in the rocks shows that many millions of years ago southwestern Illinois lay below sea level. It was covered with salt water which was sometimes clear and sometimes more or less muddy. At times when it was free from ordinary mud it usually had some particles of lime which came from the breaking up of shells. At all times the solid material in the water was gradually settling to form layers of limestone, shale, or sandstone according to the kind of sediment. Such conditions prevailed throughout much of the Ordovician, Silurian, Devonian, and Carboniferous periods except that at several different times the surface rose above sea level and was land. This came about through very slow movements such as seem to have affected the outer part of the earth throughout its history and may be in progress today. There was no violent upheaval or eruption, for such events are recorded with great clearness and certainty in the rocks and could easily be detected. In the periods of emergence there were times when deposits of mud and sand accumulated on the land rapidly—just as today in favorable situations mud and sand accumulate on land as rapidly as under water. At other times deposition ceased and rain and streams washed away some of the material that had just been deposited. After such events, when deposition was resumed, the sediment was laid down on a more or less uneven surface and the result is now an *unconformity* in the rocks. The sea was not deep like the central parts of the great oceans but was shallow like the sea margins today within a hundred miles of land. The ocean migrated widely and occupied almost every possible position. Sometimes southwestern Illinois was possibly hundreds of miles from land and at other times it was just off shore. Sometimes land was nearer in one direction and sometimes in another. Probably there were times when the water that covered this region was an inland sea, being separated from the open ocean by a strip of land. Since Carboniferous time the region has in all probability been continuously a land area subject to the wearing and washing action of water and streams. If any sediment accumulated between Carboniferous and Quaternary time it was of small amount and has since been entirely removed. The Quaternary period was the time of glaciation. Within this period there were several epochs when ice advanced from the north, but only once did it reach southern Illinois. This time it buried the former surface under so much dirt and stones that after the ice had melted streams took new courses, in some cases at right angles to their

old ones. Indeed the stream courses have not been the same in any two successive geologic periods, for in the first place all stream courses are slowly migrating, and in the second place every submergence means a more or less complete filling and obliteration of the valleys.

## Structure.

By structure is meant the arrangement and lay of the beds. The structure of this region as a whole is monoclinal; that is, the rocks dip in one general direction (to the east). Just east of St. Louis, the Herrin coal (No. 6) is about 400 feet above sea level and it outcrops along the Mississippi bluffs. (See Plate II.) It slopes to the east, reaching sea level, or 450 feet below the surface, near Carlyle, and about 100 feet below sea level at Sandoval. The average dip is 10 feet to the mile. The rocks are highest in the southwestern part of the district where they were affected by an uplift which would carry the Herrin coal at Valmeyer in the western part of Monroe county up to more than 2,500 feet above sea level, or more than 1,800 feet above the present highest hill tops. In other words, at Valmeyer there are rocks outcropping at the surface which belong 2,000 feet below the Herrin coal (Plate V).

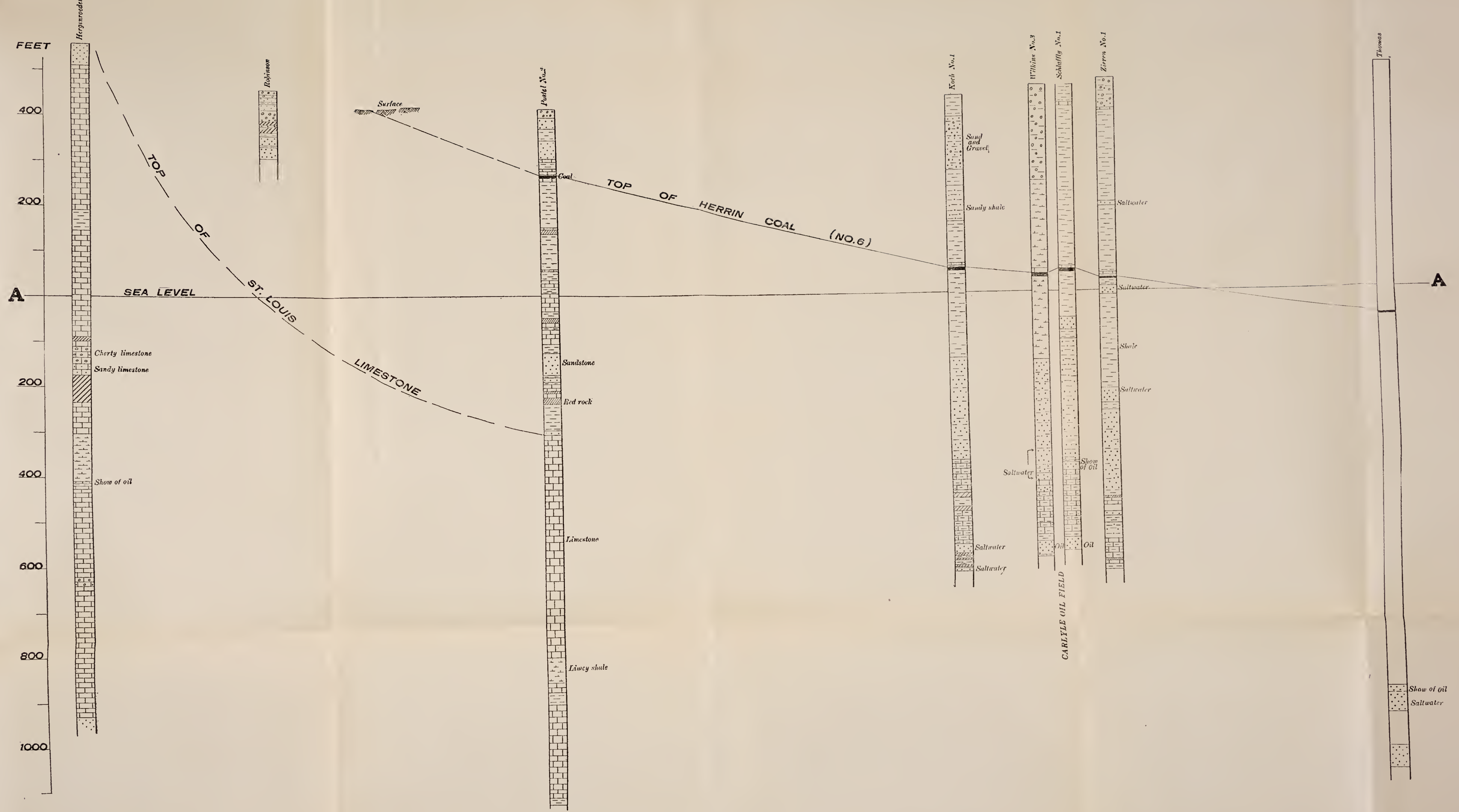
The rocks do not have a uniform dip to the east but are folded into irregular shapes; moreover they are locally broken and displaced. In some places where there is a break, the rocks on one side have moved up several hundred feet above the rocks on the other side and no one can tell how much lateral movement there has been.

The deformation just outside the region treated in this report no doubt affected the rocks in this area to a certain extent. At least the eastward dip described above is not regular, but the folds are very low and can be worked out only by careful measurements.

### Method of Representing Structure.

The best method of showing the exact shape of any worked surface is by the use of contour lines, and the writer believes that it would be well worth while for every oil operator to become accustomed to the use of the contour map. (See Plate II.) The idea is simple—that of drawing lines through points of equal altitude on some particular rock surface—and the result shows the exact shape of that surface. For example, a contour map of the surface of the earth shows the form of hills and valleys; it shows not only where the slope is steep and where it is gentle; but also the degree of steepness and the altitude of every point.

The same idea is used in showing the structure of the rocks. A reference layer or surface is chosen, for example, the top of a certain coal bed. The altitude and dip of this surface are determined at as many points as possible and if these points are at all numerous, the altitude and dip in the unknown intervening areas can be determined with considerable accuracy by constructing a contour map. But in making a structure map the geologist is not limited to data on the one layer of




Structure section along line A—A of Plate II from Monroe county northeast through Carlyle oil field.

rock upon which the map is based, for all the layers of rock are approximately parallel and the distance between the beds can be determined. For example, in the Carlyle oil field there is a bed of limestone 340 to 350 feet above the Herrin coal and the position of the coal can be estimated with fair accuracy from the position of the limestone, without sinking a hole to the coal.

## USE OF STRUCTURE CONTOURS.

The structure map has numerous uses and none are more important than its use for oil and gas prospecting. A significant fact which many oil prospectors have failed to appreciate is that the oil pools of Illinois are without exception found where the rocks have a certain geologic structure. The oil is found in areas where the rocks are higher than in adjacent territory in at least two directions and commonly in three or four directions. It would appear therefore to be almost a waste of money to sink prospects in synclines or places where the rocks are lower than in surrounding territory.

## ACCURACY OF STRUCTURE CONTOURS.

The accuracy of structure contours depends on three factors. First, the accuracy of the altitudes obtained directly; second, the difference between the actual and the assumed distance to the key rock; third, the number and distribution of points on the key rock whose altitudes have been determined.

(1) In the area under consideration, good surface maps have been published and there are numerous bench marks showing exact elevations above sea. From these, level lines were run to all points where a recognizable stratum could be located in natural outcrop or artificial excavation. In many wells the drillers have not determined the depth of the coal with exactness but in such cases the uncertainty has been reduced by checking the reported position of the coal with the determined positions of other strata at or near the same place.

(2) With regard to the second factor mentioned above, the strata are not exactly parallel, or, in other words, the distance between any two layers is not the same at all points. The variation is not great, particularly in a small district, and where the distance between the layers of rock is only a few hundred feet. In a single township the distance between any two strata is not known to vary more than 15 or 20 feet, and in general this distance has been measured in at least one place in every township. The possible error arising in this way is therefore believed to be small; not more than 20 feet at most and that in only a few places.

(3) The third factor is most important for, although in some districts there are numerous and well distributed points at which the altitudes of recognizable strata have been determined, in many parts of the area such information is scarce because outcrops are few or wanting and no wells, test holes, or coal shafts have been sunk to a bed that can be

recognized. The region in which information is most abundant is, of course, the Carlyle oil field. Elsewhere the lay of the rocks is best known where coal mines are most abundant.

In some places surface features can be used to a certain extent in working out the structure. The most conspicuous example is the uplift of the rocks in the western part of the area, resulting in higher country near the Mississippi than at some distance away. There are other areas where hard layers of rock have had an influence on the surface, but the effect is generally obscure because of the thick mantle of gravel and clay which was deposited over this region by the ice.

Allowing for the possible errors noted above, it may be assumed that the contour lines are accurate within one-half a contour interval, or 25 feet, but that locally there may be a greater error.

The prominent structural features of the region under discussion (Pl. II) are several more or less isolated domes, some of which are longer in one direction than in another and hence are better described by the word anticline.[1]

### CARLYLE ANTICLINE.

The Carlyle anticline or elongated dome is a very low arch, the central line of which extends from the Baltimore & Ohio Railroad about midway between Carlyle and Beckemeyer a little east of north for three or four miles. The highest part is near the middle where the rocks are only a little higher than they are to the north. They are, however, higher than the same beds to the east, south, or west and this dip of the rocks in three directions away from the center of the dome seems to be the most important fact in the development of an oil pool.

As every oil pool in Illinois is located on an upward bend in the rocks it would seem well worth while in prospecting to search for such localities.

At Carlyle and Beckemeyer and for some distance south and southwest the Herrin coal (No. 6) is 15 or 20 feet above the sea; to the east and southeast it dips to 50 or 60 feet below sea level in the vicinity of Huey. Northwest from Carlyle the coal rises toward the center of the field where it is 50 to 60 feet above the sea. West from Carlyle the coal dips gently again almost to sea level, but northwest it does not sink so low and it is not known to lie within 25 feet of sea level anywhere northwest of the pool. To the north and northeast, however, it descends to an altitude of 15 to 30 feet above sea in a distance of 2 or 3 miles.

It may seem remarkable but it is a fact that the shape of the Carlyle oil pool does not correspond to the shape of the anticline as it is developed in the coal-bearing rock. The place where the coal is highest is well to the northwest of the center of the pool; but when the variable thickness of the strata is remembered, the surprising fact is that the

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[1] An anticline, it should be remembered, is an upward bend or wrinkle in the rocks. The upbend to which the word is generally applied has a much greater length than breadth. An upward bend having nearly equal length and breadth is more concisely described by the term dome.

outline of the dome in the coal-bearing rocks is so near the outline of the pool. Layers of sandstone in particular vary greatly in thickness, and it is surprising that when many such layers are piled one on top of another the uppermost is so nearly parallel to the lowest.

Another important fact is that the structure of the rocks has no direct effect on the surface configuration. The fold is so slight and the processes which modify the surface (stream erosion, glaciation, etc.) have been so active that it requires a keen eye to pick out any surface features that are even indirectly controlled by the lay of the rocks.

### IRISHTOWN ANTICLINE OR STRUCTURAL TERRACE.

In the central part of Irishtown township, 5 to 7 miles north and 2 to 3 miles east of Carlyle, the coal lies 50 to 70 feet above sea. The details of the structure in this vicinity are not known for there are few outcrops and artificial excavations which show recognizable strata, but the coal is certainly higher than it is midway between this district and the Carlyle anticline, and it is considerably higher than the same bed a few miles to the east. Apparently there is a low anticline here which plunges and fades out to the east. Two wells drilled here in the fall of 1911 obtained no showing of oil. The highest known point in the coal in Irishtown township is at the Ohio Oil Company's well on the Michel farm near the middle of section 17, but as the sands and the coal are not absolutely parallel the highest point in the sands may be a mile or two away from the middle of section 17.

### BARTELSO DOME.

There is fairly good evidence of a low dome one to two and a half miles north and a little east of Bartelso. Five wells have been sunk in the vicinity of Bartelso and both the coal and the sands seem to be rising toward a point a short distance to the northeast of the town and indications of oil have been found. Four to seven miles north and northeast of Bartelso the strata are low and probably barren of oil; but between this place and the town there is possibility of a pool.

### HIGHLAND DOME.

At Highland the rocks are 25 to 50 feet higher than they are two or three miles to the east, south, or west, the coal in the northwest part of town being 230 feet above sea; but a test hole 1,089 feet deep was sunk not far from the center of the dome in 1889 and no showing of oil or gas was found. It therefore seems probable that this dome, like some others, contains no oil or gas. The record of the test is as follows:

*Record of test hole at Highland.*

| | Thickness— | | Depth— | |
|---|---|---|---|---|
| | Ft. | In. | Ft. | In. |
| Drift | 66 | | 66 | |
| Limestone | 4 | | 70 | |
| Shale, black | 3 | | 73 | |
| Clay | 7 | | 80 | |
| Clay, shale | 16 | | 96 | |
| Shale, black | 6 | | 102 | |
| Limestone, brown | 28 | | 130 | |
| Shale | 55 | | 185 | |
| Sandstone (water) | 73 | | 258 | |
| Clay, shale, blue | 10 | | 268 | |
| Clay | 10 | | 278 | |
| Red rock | 2 | | 280 | |
| Limestone | 22 | | 302 | |
| Shale | 5 | | 307 | |
| Sandstone, dry | 12 | | 319 | |
| Shale | 12 | | 331 | |
| Sandstone, dry | 6 | | 337 | |
| Shale | 20 | | 357 | |
| Sandstone (water) | 39 | | 396 | |
| Shale | 20 | | 416 | |
| Sandstone (water) | 40 | | 456 | |
| Shale, black | 6 | | 462 | |
| Sandstone, dry | 6 | | 468 | |
| Shale, black | 35 | | 503 | |
| Coal | 1 | 10 | 504 | 10 |
| Clay | 10 | | 514 | 10 |
| Sandstone, "shell" | 5 | | 519 | 10 |
| Coal | 1 | 2 | 521 | |
| Clay | 4 | 6 | 525 | 6 |
| Shale, black | 54 | 6 | 580 | |
| Sandstone (water) | 25 | | 605 | |
| Shale, black | 25 | | 630 | |
| Shale | 75 | | 705 | |
| Limestone | 4 | | 709 | |
| Shale | 30 | | 739 | |
| Sandstone (water) | 29 | | 768 | |
| Shale | 27 | | 795 | |
| Limestone, brown | 6 | | 801 | |
| Shale | 4 | | 805 | |
| Limestone | 8 | | 813 | |
| Sandstone, red | 2 | | 815 | |
| Shale, red | 4 | | 819 | |
| Sandstone (water) | 8 | | 827 | |
| Shale | 3 | | 830 | |
| Sandstone, brown | 20 | | 850 | |
| Red rock | 12 | | 862 | |
| Shale | 6 | | 868 | |
| Sandstone, brown (water) | 19 | | 887 | |
| Shale, sandy, green | 15 | | 902 | |
| Sandstone, green | 18 | | 920 | |
| Sandstone, white (water) | 92 | | 1,012 | |
| Limestone | 77 | | 1,089 | |

## HOFFMAN DOME OR ANTICLINE.

At Hoffman, about 11 miles east of Bartelso, the strata are high, the coal according to a diamond drill record being 37 feet above sea, whereas a very few miles to the northwest, north, and east, it is below sea level. It may dip to the south also, and if so the structural feature is a dome; otherwise it is an anticline, which plunges to the northeast. In either case it is well worth a test for oil.

The structure between Hoffman and Bartelso is not known. Most likely there is a shallow syncline but there is a possibility of a small arch.

### NASHVILLE ANTICLINE.

At Nashville the strata have a noticeable rise to the west, but a mile north of Addieville they seem to be 50 feet lower. From what is known of the lay of the rocks there appears to be a broad but fairly steep sided anticline plunging slightly to the northeast but perhaps extending without a break northeast to the Hoffman dome. There is some indication that the anticline is double crested, one crest being southeast and one northwest of Nashville. To the southwest the anticline becomes less pronounced. At Oakdale it appears to be broad and low, though farther to the southwest toward the Sparta field it may become higher and steeper. It may be, however, that this uplift is not an anticline but a dome. If so its position is 2 to 4 miles west of Nashville.

### VENEDY DOME.

In a deep well near the old town of Venedy about 6 miles southwest of Okawville the coal is reported to lie at a depth of 212 feet, or 250 feet above sea. This is higher than it lies in surrounding territory but the details of this dome or anticline are not yet known.

### DARMSTADT ANTICLINE.

The Darmstadt anticline has a northeast-southwest trend, and is somewhat irregular. It probably extends northeast to the Venedy uplift, beyond which it appears to be double crested, one crest running nearly north to New Memphis, and the other northeast to Okawville. The anticline seems to be highest near Darmstadt, where the coal bed reaches an elevation of 298 feet above sea, whereas it is 50 to 75 feet lower to the west, north, and east. It may or may not be lower to the northeast, and there is a possibility that it is lower to the south and is a dome. It is at least a well marked uplift, flanked on the northwest and southeast by synclines, and is one of the most worthy places in the region for a test well.

### WHITE OAK ANTICLINE.

A low anticline plunging gently to the northeast extends in a southwest-northeast direction through White Oak, where it is unsymmetrical, the southeast limb being rather steep and about 40 feet high, and the northwest being less than 10 feet high. It thus has somewhat the form of a terrace facing southeast, but the distinct slope to the northwest makes it an anticline. To the southwest its limits are not known. It may extend as far as Baldwin. To the northeast it appears to broaden and to extend nearly to Lively Grove. The highest known point is 6 or 7 miles east and 2 miles north of Marissa, where the coal is reported in a test hole to be 295 feet above sea. This is higher than the coal lies either to the northwest, northeast, or southeast. But, unfortunately, there is very little information on the position of the strata in this district, and hence the structure is somewhat doubtful. There may be a dome just northwest of the middle of Lively Grove township, and the

anticline may be high or low, steep sided or gently sloping. But in any case, the anticline should be tested before adjacent territory. One test has already been sunk near White Oak and no oil was found. Another test on this anticline might very well be located 5 or 6 miles northeast of White Oak.

### OTHER ANTICLINAL FEATURES.

At several places in the area under discussion, structures favorable for the accumulation of oil and gas have already been pointed out by R. S. Blatchley of the State Geological Survey (See Bulletin No. 16, Ill. Geol. Survey, 1911, pp. 42-177, inclusive). These places are enumerated by him as follows:

1. A flat "terrace" at O'Fallon.
2. A low arch at Aviston.
3. A small anticline west of Belleville, perhaps corresponding to the O'Fallon deformation.
4. A small arch east of the Belleville, perhaps corresponding to the O'Fallon deformation.
5. A small arch east of Mascoutah apparently corresponding to the Aviston deformation.
6. A probable structural terrace between Beaucoup and Ashley in Washington county.
7. A flat at Marissa.
8. An anticline at Tilden.

The new data on these features are indicated in the following paragraphs:

1. At O'Fallon the strata have the form of an anticline rather than a terrace, though the east limb is higher than the west limb. The anticline is somewhat broad at Aviston and to the north, in which direction it extends 3 or 4 miles. To the south it becomes narrower to a point just east of Belleville, beyond which it is not known to be developed.

2. At Aviston the general eastward dip of the strata seems to be modified by an upward bend, probably not over 15 feet in height. The arch falls between two of the 50-foot structure contours, and hence it is not shown on the structure map.

3. Concerning the small anticline west of Belleville no new data have been collected.

4. The anticline east of Belleville is, as indicated above, a continuation of the one at O'Fallon.

5. The presence of an arch east of Mascoutah was inferred from the fact that according to the log of the Postel No. 1 well, drilled in 1893, the coal lies higher there than in the Beatty mine a half mile north in the north edge of Mascoutah, but the fact that at the Kolb mine southeast of Mascoutah and in the Postel well No. 2 the coal is reported at about the same position as in the Beatty mine, and also the fact that in the coal mines the coal bed does not show any indication of anticlinal structure nearby, makes it appear probable that the Postel No. 1 record is slightly incorrect. In any case, since this well is not east of the Beatty mine, the anticline if present would be a small one in Mascoutah.

6. The record of the Shaffer and Smathers well near Ashley makes it appear that the structure between Beaucoup and Ashley is synclinal and not favorable for oil and gas accumulation, but not enough is known to warrant a definite statement.

7. The new information indicates that the beds at Marissa are bent downward forming a shallow syncline flanking the White Oak anticline on the northwest instead of being folded in a flat topped anticline as previously thought.

8. The anticline at Tilden is much lower than was formerly supposed, being less than 10 feet in height. The crest lies about a mile west of Tilden.

## THE CARLYLE OIL FIELD.

### History.

The Carlyle oil pool was discovered early in April, 1911, two wells, Smith No. 1 and Murphy No. 1, reaching the pay sand within a few days of each other. Before this, two wildcat wells, about a thousand feet deep, had been drilled just south of Carlyle, and a showing of gas, hardly enough to stimulate prospecting, was found in one. The existence of producing wells 12 to 15 miles east of Carlyle in the Sandoval pool which was opened in the summer of 1909, served, however, to make men study the surrounding country, and in 1910 Murphy No. 1 was located by Mr. W. W. Laird, President of the Surpass Oil and Gas Company. It is about 5 miles northwest of Carlyle. (See map of Carlyle oil field, Plate II, in pocket.) Plans were made to drill to a depth of 2,000 feet, and 13-inch casing was carried to 725 feet. Numerous difficulties were encountered and drilling proceeded slowly so that it was several weeks before the hole reached a depth of 750 feet where a showing of oil was found. Late in the year another showing of oil was found at 860 feet. Further difficulties and accidents hindered the drilling and little progress was made through the winter. In March, 1911, the third sand containing oil was found at a depth of 1,013 feet and was shot with 60 quarts of nitro-glycerine. The shot failed to bring oil in paying quantities but the drillers proceeded to clean out the well in the hope that it would turn out better and a 250-barrel tank was built nearby. The oil found was enough to make holders of leases in the vicinity imagine that the well was just on the edge of a pool and a lease a short distance away might contain oil in paying quantities. The result was a test well half a mile south and a little east on the northeast corner of the Smith farm. The lease on this farm was held by F. B. Ranger and drilling was begun about the middle of March.

Owing in part to the fact that a big rental payment was due in about three weeks from the time it was started, work on the Smith well was rushed so that the lease might be given up before the payment was due if oil was not found.

On April 8th a good flow of oil was struck in the Smith well at a depth of 1,030 to 1,056 feet. The well began to flow at a rate of 100 barrels or more a day before it was shot. The news spread rapidly and within twenty-four hours there were scores of oil speculators and operators in Carlyle. It was conservatively estimated that over 500 people paid a visit to the new well on Sunday, April 9th. During the following week rains checked travel, but the hotels in Carlyle were crowded to their utmost capacity and many men went to the neighboring towns, particularly to Beckemeyer, for hotel and livery accommodations. The crowd included leasers, operators, contractors, drillers, and a multitude of "floaters" without any special calling. Citizens were besought for sleeping accommodations; campers, usually with poor equipment, went to the river bank and roadsides, and many slept on the courthouse lawn.

During the first few weeks of the boom the main feature of the oil business was the scramble for leases. Bonus prices bounded up to more than a hundred dollars an acre for land that could have been bought outright a few months before at not more than fifty dollars an acre.

By the last of April twenty drilling outfits were on the ground and several railway oil tanks had been filled and shipped from Beckemeyer.

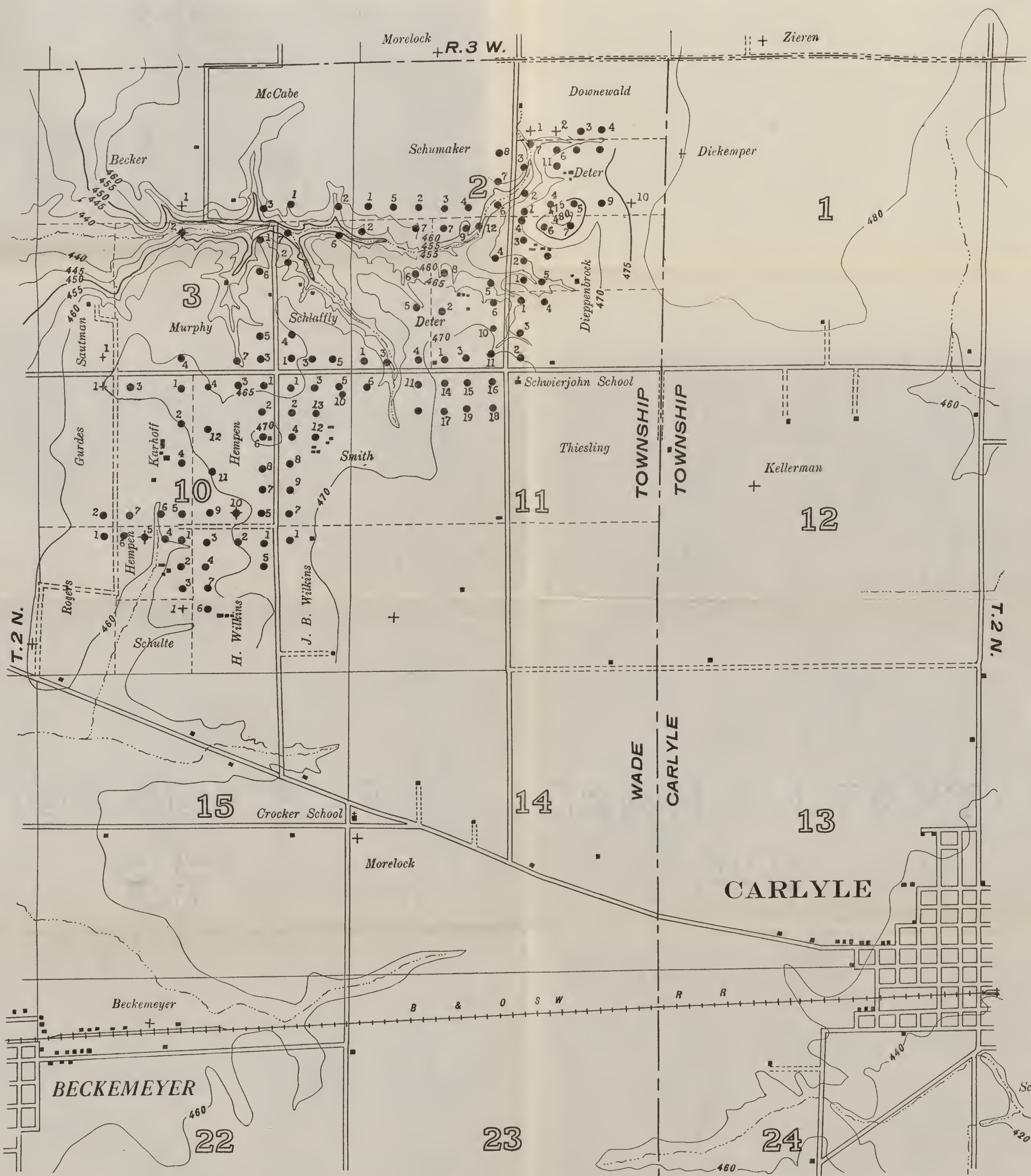
Many land owners were slow about leasing and a variety of means were used to pursuade and coerce them. It is said that one farmer's son was paid $5.00 a day to influence his father. On the central streets of Carlyle were to be seen at all times of day groups of men negotiating with land owners or lease holders for leases, and some speculators cleared large sums of money.

But success was not in store for all. The new wells which were started were scattered over much of Clinton county, though they were more numerous near the Murphy and Smith wells. Out of sixteen prospect wells begun before the end of April, twelve turned out to be dry; but in May several good wells were brought in near the original ones and interest did not lag.

In May and June the producing territory was extended over several farms, but many dry holes were sunk in all directions from the pool and neither an extension nor a new pool was found. This brought on a reaction that inevitably follows a boom and for a time discouragement prevailed. Prices of oil and other properties declined and many men left the region.

Nevertheless, the production of the pool increased without interruption. About the middle of June a pipe line was completed from Sandoval and the oil, including much that had accumulated in storage tanks was conducted to that town and thence to the refineries at Alton.

During the remainder of the summer the boundaries of the pool were extended gradually out to dry wells in all directions. To the northeast in particular the limits spread out much farther than anyone had




# MAP OF CARLYLE OIL FIELD, ILLINOIS

BY

EUGENE WESLEY SHAW

OF THE

UNITED STATES GEOLOGICAL SURVEY

PREPARED IN CO-OPERATION WITH THE

STATE GEOLOGICAL SURVEY

DECEMBER, 1911

LEGEND

● Oil Well

+ Dry Well

Abandoned Well

Township Line

Property Line

LEGEND

Contours showing elevation of surface above sea level. Contour interval: In oil field 5 ft., outside of oil field 20 ft.

Buildings

N W E S

Scale Of Miles

0 1 2

Drawn by A.R.Alger

Map of Carlyle oil field showing topography and location of properties and wells.

expected. The lease on the Downewald farm, for example, would scarcely have brought a dollar an acre at the time of the depression in the early part of the summer, but by the end of October it was worth more than a hundred dollars an acre.

## Topography of Carlyle Oil Field.

The land surface in the vicinity of the Carlyle oil pool is nearly flat and level and stands at an average elevation of about 465 feet above sea level. (See Plate VI.) There are a few knolls reaching 470 feet and several of the small stream valleys are cut below 460 feet. The Hempsen House stands a little above 470 feet, the road corner at the Schwierjohan School is 471 feet and the northeast part of the field is almost 475 feet above sea. Just to the north and east of the pool are knolls which rise above 480 feet. To the east and west the surface slopes down toward Beaver creek and Kaskaskia river which flow here a little over 400 feet above sea. To the south the surface has an altitude of about 465 feet.

## Geology.

### stratigraphy.

The stratigraphy of the Carlyle oil field is much the same as that already described for the region in which it lies; but that part of the section which has been penetrated by the oil wells is known in much greater detail than any part of the section in the remainder of the region. (See Plates III and IV.)

*Chester group.*—That part of the Chester group lying below the principal producing sand which has become known to the drillers as the Carlyle sand, is known from only a few wells and consists of one or more heavy sandstones (50 to 125 feet thick), interbedded with limestone and shale. The principal sandstone is known as the Cypress sandstone. The Carlyle sand is, on the whole, a soft porous, medium-fine grained sandstone of irregular thickness, and with numerous partings. Around the edges of the pool it is harder than in the center and in one or two places pinches out entirely. Above the Carlyle sand is about 30 feet of bluish shale containing in some places one or two beds of limestone and, in some places, red shale. The next hundred feet is even more variable. There is everywhere some shale at this position and generally, if not everywhere, a bed of hard limestone in the lower part and a bed of sandstone near the top. In some places most of the rock 30 to 130 feet above the Carlyle sand is limestone. The next 70 feet is predominantly shale, but there is some limestone, and in the northwestern part of the pool a heavy bed of sandstone occurs in the upper part.

*Pottsville sandstone.*—The Pottsville sandstone is about 160 feet thick and its base is about 200 feet above the Carlyle sand. It consists of several heavy beds of sandstone, separated by layers of shale. This sandstone is generally filled with salt water and hence is coming to be known as the "salt sand"; but along the northern border of the pool

there is much gas and some oil in the lowermost part of this sand. Along the west side there is gas and water in this lower part. In McCabe No. 1, in the northwest corner of the pool, a flow of gas was strong enough to carry up quartz pebbles from the sand.

*Carbondale formation.*—The Carbondale formation which extends from the top of the Pottsville to the top of the Herrin coal (No. 6), is about 225 feet thick in the vicinity of Carlyle. A bed of sandstone which in the lower 50 feet of this formation varies in thickness from 10 to 40 feet or more, is almost everywhere present. This rock generally contains salt water and hence is commonly included by the drillers with the underlying "salt sands" (Pottsville). It differs from them in being somewhat softer and in containing a large amount of mica and other material beside quartz. Below this sandstone there is in some places a layer of limestone and almost everywhere a bed of shale separating it from the Pottsville sandstone below. The central part of the Carbondale formation is predominantly shale. In some places it is somewhat sandy and elsewhere it contains more or less lime, but beds of pure limestone are generally absent. A short distance below the Herrin coal there is generally a bed of sandstone which in the Carlyle oil field is dry; but in the vicinity of Centralia, about 15 miles east, it has in places a good showing of oil. Above this sandstone there is commonly a bed of limestone, and above the limestone is the Herrin coal (No. 6) which marks the top of the formation.

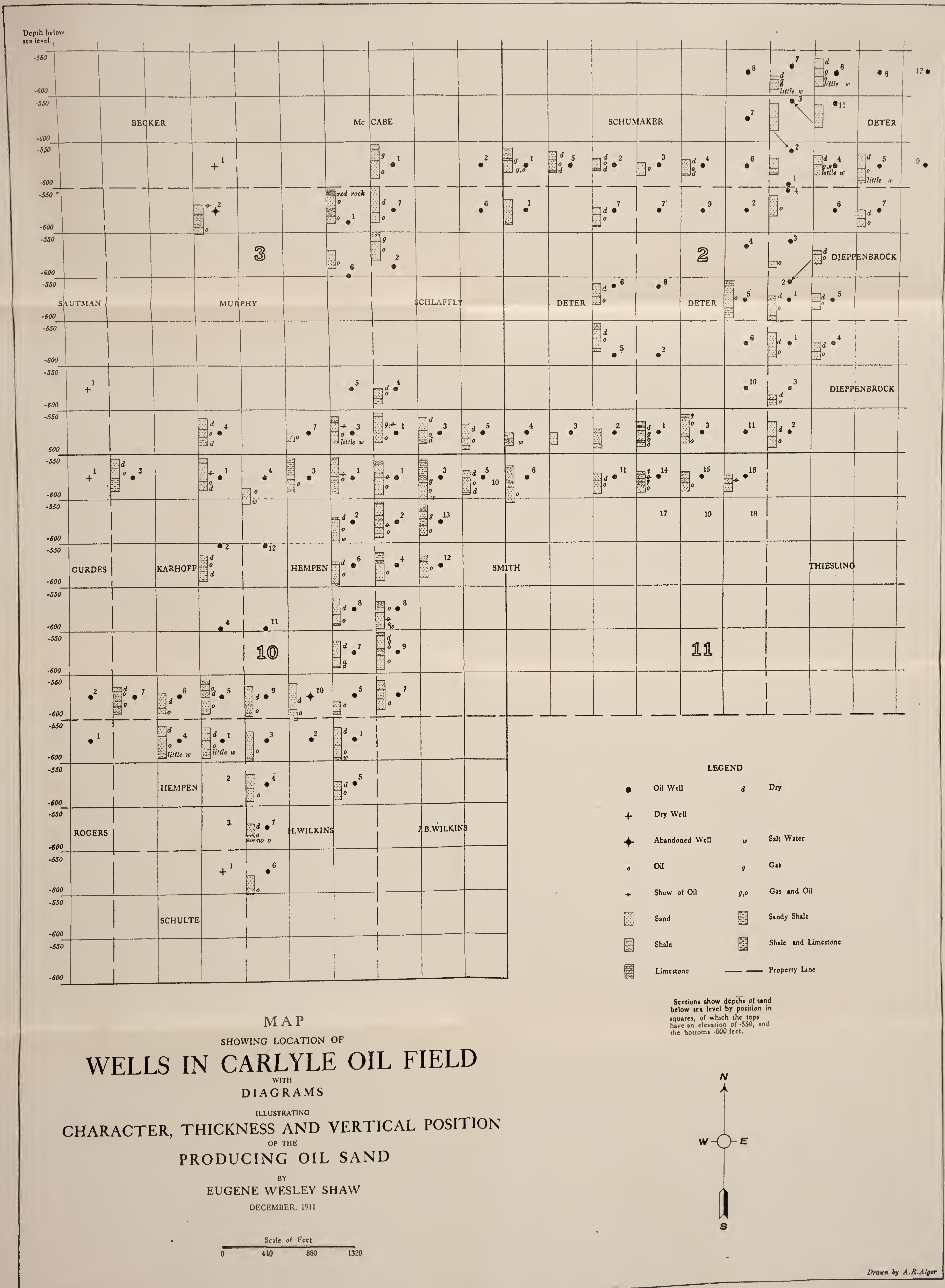
*McLeansboro formation.*—That part of the McLeansboro which is present in the Carlyle field extends from the top of the Herrin coal to the top of the Shoal Creek limestone of Illinois Survey reports. It consists principally of shale with a bed of limestone near the base overlying the Herrin coal, and with another limestone at the top; the latter limestone being in some places separated into two divisions. This upper limestone generally constitutes the bed rock under the surface clay and gravel and hence is used as a seat for the drive pipe.

*Quaternary deposits.*—The Quaternary deposits in the Carlyle oil field consist of gravelly clay about 30 feet thick, overlain by clay (loess), almost without perceptible grit, ranging up to 20 feet thick. There is very little, if any, well washed gravel but in some places there is sand with some pebbles which is free enough from clay to be known as quicksand. Sand lenses of this sort have made trouble in drilling and handling the drive pipe in some wells.

## STRUCTURE.

The structure of the rocks in the Carlyle field could be shown with little difficulty if the beds underlying the Herrin coal, including the oil sands, were all parallel to the coal. A study of well logs shows, however, that in the pool the Carlyle sand is nearly horizontal (Plate VII); whereas the coal is highest along the north side of the field and dips most rapidly to the west and southwest. The dip to the east and southwest is gentle for a mile or more, and then becomes much greater.

Plate VII is a map which presents considerable information regarding the oil sand.




Map showing elevation, character, and thickness of Carlyle oil sand.

The data for this map are taken largely from drillers' records, but partly from determinations made by the writer. The map shows: (1) The location and name of each well and the character of the production. (2) The character so far as known of the oil-bearing sand with its overlying and underlying rock. (3) The depth of the sand below sea level at most of the wells and hence the structure of the sand. A row of diagrams taken in any direction gives a cross section of the sand in that direction. The position of (1) the top of the sand, (2) top of pay, (3) bottom of pay and bottom of hole, are also shown as far as possible. The position of the sand at each well is determined from careful steel line measurements made for the placing of the shot and from the elevation of the platform of each well determined by spirit level.

Outside the field the sand dips in all directions except north, and apparently it also pinches out in all directions except to the north. The small irregularities in the position of the sand are probably not accurate, but arise out of the fact that one driller will call for example a sandy shale sandstone, whereas another driller will call the same rock shale. Some drillers even call certain limestones, shale.

## COMMERCIAL CONDITIONS.

*Product of the wells.*—All of the wells of the Carlyle oil field yield gas, oil, and water, the amount of each varying considerably from well to well. The initial production of oil ranges up to 2,000 barrels a day, Murphy No. 5 having flowed about that amount in the first twenty-four hours. The average initial production is about 100 barrels and the average production after two months is about 50 barrels. A few wells on the outskirts of the pool have yielded less than 50 barrels on the start, and many have yielded between 200 and 300; the yield of the wells varies, therefore, considerably but not enormously.

The flow of gas is strong in all wells, particularly those in the north part of the pool. The exact amount of gas has not been determined in any well, and in but one well, McCabe No. 1, has the closed pressure been measured. It was said to show a pressure of about 80 pounds, but in many wells the gas is at times strong enough to lift a 500-foot column of oil and water. Several days after it was shot, Shaffer & Smather's Deter No. 2 developed enough gas to force the bailer (weighing several hundred pounds) out of the hole and up to the top of the derrick.

A few wells such as Shaffer & Smather's Deter No. 1 have yielded no perceptible water at first but at such wells small quantities of water soon begin to appear and in a few weeks a considerable part of the production is water.

The relation of the water to the oil has not been fully determined but it seems that the producing sand contains both water and oil and that to the north the sand is saturated with water. Generally the water is in the lower part of the sand and the oil in the upper part, and in no good oil well has a strong flow of water been found in the sand above the oil; but in many wells the oil is present in several pay streaks separated by more or less non-porous sand or shale and with some water.

Many of the best wells have yielded from the beginning twice as much water as oil. The production of these wells does not appear to have dropped off more rapidly than any other wells, and the proportionate amount of salt water has remained about the same. It does not appear, therefore, that the pool is being flooded with salt water, though after some time such a condition may develop. It seems that oil, water, and gas are all three confined in the porous part of a layer of sandstone and that the production of the field will be limited only by the pore space in that sandstone.

The total thickness of the pay sand averages 10 or 12 feet. The pore space has not been determined but probably amounts to about 10 or 15 per cent of the rock. The total amount of oil in the pool, therefore, may be very roughly estimated to be about 10,000,000 barrels. The minimum quantity recoverable is probably over a half, and possibly three-quarters or more, depending upon the movement of the water.

The gravity of most of the oil is somewhat above 33 degrees Baumé; some of it is as high as 37 or 38, and some is a little below 33 degrees. A sample from the south side of the Dieppenbrock farm was examined by Dr. David T. Day, who says that it is "well suited for refining, and is rich in good gasoline and illuminating oil," and that it is "of the Crawford and Clark county type." This sample had a specific gravity of 0.8563 or 33.5° B. It began to boil at 105° C. Between 105° and 150° it yielded 8cc of oil with a gravity of 0.7445 and between 150° and 300° yielded 33cc of a sp. g. of .1016. The residuum 57.5cc had a sp. g. of .9126.

The oil from wells on the edges of the pool is remarkably dark and heavy. A sample from the Schulte farm at the southwest corner of the field yielded upon analysis only half as much gasoline and a third as much kerosene as the oil from within the pool and it showed the oil to be unsuitable for ordinary refining purposes.

There is a rather large amount of waste oil but this is steamed and the part now actually wasted appears to be less than one per cent of the whole production. The waste oil is burned in open pools and ditches, at considerable expense.

*Costs.*—The price of leases includes about a dollar an acre as annual rental, and one-eighth of the oil and gas produced. In addition to this a "bonus" is commonly paid, the amount varying from a few cents to several hundred dollars an acre, according to the probability of getting oil. The leasers receive either a salary or a commission of from one to ten cents an acre for the leases they secure. The contractor's price for drilling is now $1.10 to $1.25 per foot, but was more at first on account of uncertainties regarding the character of the strata. It is greater in the case of deep wells, such as those which have been drilled over 2,000 feet, for which the contract price is about $2.00 per foot. The contractor bears the expense of everything but the casing and the shooting. He pays $5.00 a day for fuel, $3.00 a day for water, about $6.00 a day to each of his drillers, and $5.00 to each of the tool dressers. After drilling is completed the contractor receives about $20.00 a day for cleaning out the well. Pumps, power houses, and tanks constitute a large item of expense and the upkeep of the wells involves

a considerable outlay. Each lease has its power houses from which all the wells are pumped by means of "jacks." After drilling is completed, three or four men, including farm boss and pumpers, are given steady work on each lease.

*Method of getting and handling the oil.*—The drilling apparatus used includes many kinds of machines—Star, Parkersburg, National, and others—and both turnbuckle and standard rigs. To the drillers the standard and turnbuckle rigs are most desirable, but many contractors prefer machines because of the smaller initial outlay and the lower expense of moving. The drillers and tool dressers work twelve-hour tours, changing at noon and midnight.

Four sizes of casing are used. The drive pipe is twelve and a half inches in diameter and about 50 or 60 feet long in order to reach the first hard rock. In some places where the upper limestone (Shoal Creek limestone of Illinois Survey reports) is absent, over a hundred feet of drive pipe have been used. Ten-inch pipe is used to hold the soft shales of the Carbondale and McLeansboro formations out of the hole and is about 650 feet long. Eight hundred and fifty feet of eight-inch casing are used to shut off the water from the Pottsville ("salt sands"). The smallest casing is six and a quarter inches in diameter. This holds back the soft shales of the Birdsville formation which would otherwise cave in and seriously hinder drilling in the oil sand. Over one thousand feet of this size are used.

Upon reaching the pay sand, drilling is continued with much care in order to make sure of stopping before the oil is passed and water-bearing rock tapped; but in order to be certain of having penetrated all the productive part of the sand, most wells are drilled until there are signs of increasing water or a change in the character of the sand.

The wells are shot as soon as convenient after being finished. The amount of nitroglycerine used is generally about forty quarts, though in some wells with a poor showing of oil and a close, hard sand, as much as a hundred or more quarts have been used. The shot is commonly anchored a foot or more above the bottom and is sometimes set off by the electric spark and sometimes by dropping a dynamite cartridge with a fuse, into the hole. Before the shot is fired, the smallest casing is pulled and if the well promises to be a heavy producer, lead lines are made ready and connected so that only the first flow of oil is lost. If there is not a large showing of oil before the well is shot lead lines are generally not needed until the hole has been cleaned.

Most of the wells flow within ten minutes after the explosion but many of them "bridge over," and do not develop enough pressure to break the bridge. Indeed, Murphy No. 5, the heaviest producer in the field was so effectually plugged by the shot that it was thought to be below the average until the tools were let down and the bridge broken.

After the shot, the best wells flow intermittently ("by heads") for several weeks. One well, Schomaker No. 1, had been flowing over four months at the time this examination was made. The lighter wells are "put to pumping" within a few days after being shot.

The oil goes first to a tall, slender "gun barrel" tank where most of the water settles to the bottom and flows out automatically. The oil is then conducted to a tank where it is steamed to separate more water from the oil. Finally, after the waste oil has settled, been drawn off, and the gager has measured the amount of oil, the tanks are opened and the oil is forced into pipe lines by means of small steam engines.

*Accidents.*—Several more or less serious accidents have occurred. One man was badly burned at the Bond well engine and several have received somewhat painful injuries while unloading casing. Two men have been seriously injured by blown-off well caps.

*Fire Losses.*—There has been but one important fire in the Carlyle field. This one, on the east eighty of the Deter farm was caused by a waste oil fire which became uncontrollable. Several tanks of oil and one drilling outfit were destroyed, entailing a loss of several thousand dollars.

## WELL RECORDS.

The following records have been chosen as representative of the wells in the Carlyle pool and surrounding territory:

### WELLS IN THE CARLYLE FIELD.

*Well No. 4 on Henry Wilkins farm.*

Location—S. E. ¼ sec. 10, T. 2 N., R. 3 W.
Altitude—465 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Clay, sand and gravel, containing some peat, water, and gas | 130 | 130 |
| Shale | 20 | 150 |
| "Shell" | 10 | 160 |
| Shale | 20 | 180 |
| Sandstone (water) | 15 | 195 |
| Shale | 35 | 230 |
| "Shell" | 10 | 240 |
| Shale | 110 | 350 |
| Limestone | 20 | 370 |
| Shale | 20 | 390 |
| "Shell" | 30 | 420 |
| Shale | 15 | 435 |
| Coal | 2 | 437 |
| "Slate and shells" | 243 | 680 |
| Sandstone (salt water) | 20 | 700 |
| Shale | 45 | 745 |
| "Shell" | 15 | 760 |
| Shale | 55 | 815 |
| "Cave" | 25 | 840 |
| Limestone | 30 | 870 |
| Shale | 20 | 890 |
| Limestone | 60 | 950 |
| Shale | 15 | 965 |
| Limestone | 20 | 985 |
| Shale | 19 | 1,004 |
| "Shell" | 14 | 1,018 |
| Shale | 5 | 1,023 |
| "Shell" | 3 | 1,026 |
| Shale | 3 | 1,029 |
| Sandstone (dry) | 17 | 1,046 |
| Sandstone (oil) | 11 | 1,057 |

### *Well No. 2 on NE. part of Deter farm.*

Location—S. W. ¼ of N. E. ¼ sec. 2, T. 2 N., R. 3 W.
Altitude—465 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Clay | 42 | 42 |
| Limestone | 8 | 50 |
| Shale | 210 | 260 |
| Limestone | 8 | 268 |
| Shale | 92 | 360 |
| Red rock | 10 | 370 |
| Limestone | 6 | 376 |
| Shale | 34 | 410 |
| Limestone | 5 | 415 |
| Coal | 5 | 420 |
| Shale | 15 | 435 |
| Limestone | 45 | 480 |
| Shale | 70 | 550 |
| Limestone | 3 | 553 |
| Shale | 37 | 590 |
| Red rock | 20 | 610 |
| Shale | 86 | 696 |
| Sandstone (salt water) | 81 | 777 |
| Shale | 63 | 840 |
| Sandstone, show of gas[1] | 10 | 850 |
| Sandstone and limestone | 5 | 855 |
| Shale | 27 | 882 |
| Limestone | 43 | 925 |
| Shale | 20 | 945 |
| Limestone | 35 | 980 |
| Shale | 15 | 995 |
| Limestone | 5 | 1,000 |
| Shale | 23 | 1,023 |
| Shale, sandy | 11 | 1,034 |
| Sandstone, show of oil | 1 | 1,035 |
| Sandstone | 6 | 1,041 |
| Sandstone (oil) | 5 | 1,046 |
| Sandstone (oil and gas) | 6 | 1,052 |

[1] In the No. 1 well on this lease 400 feet from No. 2 salt water and gas were found in this sand in such quantities that drilling was stopped for four hours.

### *Well No. 6 on Smith farm.*

Location—N. W. ¼ N. W. ¼ sec. 11, T. 2 N., R. 3 W.
Altitude—468 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Soil | 8 | 8 |
| Gravel and sand | 17 | 25 |
| Gravel | 42 | 67 |
| Lime | 20 | 87 |
| Shale, hard | 113 | 200 |
| Shale | 200 | 400 |
| Limestone | 5 | 405 |
| Shale, hard | 5 | 410 |
| Limestone | 20 | 430 |
| Coal | 6 | 436 |
| Shale, hard | 45 | 481 |
| Sand and water | 10 | 491 |
| Shale, black | 34 | 525 |
| "Slate" | 45 | 570 |
| Sandstone | 5 | 575 |
| "Slate" | 10 | 585 |
| Coal | 3 | 588 |
| Shale, black | 22 | 610 |
| "Slate" | 10 | 620 |

*Well No. 6 on Smith farm*—Concluded.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Sandstone | 19 | 639 |
| "Slate" | 36 | 675 |
| Sandstone (salt water) | 48 | 723 |
| Shale | 4 | 727 |
| Sandstone (salt water) | 31 | 758 |
| Shale | 10 | 768 |
| "Slate" | 12 | 780 |
| Sandstone and shale | 20 | 800 |
| "Slate" | 68 | 868 |
| "Shell" | 4 | 872 |
| Sandstone and shale | 18 | 890 |
| "Slate" | 15 | 905 |
| Sandstone( salt water) | 12 | 917 |
| "Slate" | 43 | 960 |
| Limestone | 12 | 972 |
| "Slate" | 10 | 982 |
| Limestone | 53 | 1,035 |
| Sandstone and shale | 8 | 1,043 |
| "Slate" | 5 | 1,048 |
| Sandstone | 18 | 1,066 |

*Well No. 1 on the McCabe farm.*

Location—S. W. ¼ N. E. ¼ sec. 3, T. 2 N., R. 3 W.
Altitude—464 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Soil | 5 | 5 |
| Clay, sandy | 56 | 61 |
| Shale | 319 | 380 |
| Limestone | 11 | 391 |
| Shale | 8 | 399 |
| Coal | 12 | 411 |
| "Slate" | 165 | 576 |
| Sandstone (salt water) | 15 | 591 |
| Shale | 25 | 616 |
| Sandstone (salt water) | 94 | 710 |
| Shale and sandstone | 130 | 840 |
| Shale | 10 | 850 |
| Sandstone (gas) | 20 | 870 |
| Sandstone (oil) | 35 | 905 |
| Shale | 45 | 950 |
| Limestone | 48 | 998 |
| Shale | 23 | 1,021 |
| Sandstone (gas) | 13 | 1,034 |
| Sandstone (oil) | 19 | 1,053 |

### *Well No. 1 on Karhoff farm.*

Location—N. E. ¼ N. W. ¼ sec. 10, T. 2 N., R. 3 W.
Altitude—469 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Soil | 25 | 25 |
| Gravel | 10 | 35 |
| "Hard pan" | 35 | 70 |
| Gravel (water) | 5 | 75 |
| Limestone | 7 | 82 |
| Shale | 118 | 200 |
| Limestone | 35 | 235 |
| Shale | 165 | 400 |
| Limestone | 5 | 405 |
| Shale | 10 | 415 |
| Limestone | 5 | 420 |
| Coal | 6 | 426 |
| Shale | 164 | 590 |
| Limestone | 10 | 600 |
| Shale | 114 | 714 |
| Sandstone (salt water) | 15 | 729 |
| Shale | 31 | 760 |
| Sandstone (salt water) | 30 | 790 |
| Shale | 5 | 795 |
| Limestone | 5 | 800 |
| Shale | 30 | 830 |
| Limestone | 10 | 840 |
| Shale | 40 | 880 |
| Limestone | 5 | 895 |
| Shale | 10 | 895 |
| Limestone | 25 | 920 |
| Shale | 10 | 930 |
| Limestone | 10 | 940 |
| Shale | 72 | 1,012 |
| Limestone | 13 | 1,025 |
| Shale | 13 | 1,038 |
| Sandstone (oil) | 21 | 1,059 |
| Shale | 16 | 1,075 |
| Limestone | 7 | 1,082 |
| Shale | 3 | 1,085 |
| Limestone | 12 | 1,097 |
| Shale | 3 | 1,100 |

### *Well No. 1 on Treat-Crawford Deter lease.*

Location—S. E. ¼ S. W. ¼ sec. 2, T. 2 N., R. 3 W.
Altitude—472 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Clay and gravel | 56 | 56 |
| Limestone | 6 | 62 |
| "Slate and shells" | 375 | 437 |
| Limestone | 1 | 438 |
| Coal | 7 | 445 |
| Shale | 224 | 669 |
| Limestone | 10 | 679 |
| Shale | 35 | 714 |
| Sandstone (salt water) | 39 | 753 |
| Shale | 12 | 765 |
| Sandstone (salt water) | 11 | 776 |
| Shale | 17 | 793 |
| Sandstone (salt water) | 5 | 798 |
| Shale | 22 | 820 |
| Limestone | 8 | 828 |

*Well No. 1 on Treat-Crawford Deter lease*—Concluded.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| "Slate and shells" | 127 | 955 |
| Limestone | 2 | 957 |
| Sandstone | 8 | 965 |
| "Slate and shells" | 63 | 1,028 |
| Limestone | 16 | 1,044 |
| Sandstone | 2 | 1,046 |
| Sandstone and shale | 3 | 1,049 |
| Sandstone (gas) | 4 | 1,053 |
| Sandstone (oil) | 5 | 1,058 |
| Shale | 2 | 1,060 |
| Sandstone (oil) | 4 | 1,064 |

## WELLS OUTSIDE THE CARLYLE FIELD.

### *Well No. 1 on Holthaus farm.*

Location—S. E. ¼ S. E. ¼ sec. 29, T. 2 N., R. 3 W.
Altitude—440 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Drift | 78 | 78 |
| Shale | 40 | 118 |
| Limestone | 6 | 124 |
| Shale | 32 | 156 |
| Limestone | 3 | 159 |
| Shale | 52 | 211 |
| Coal | 5 | 216 |
| Shale | 53 | 269 |
| Limestone | 6 | 275 |
| Shale | 35 | 310 |
| Limestone | 4 | 314 |
| Shale | 20 | 334 |
| Limestone | 12 | 346 |
| Shale | 16 | 362 |
| Limestone | 43 | 405 |
| Coal | 11 | 416 |
| Shale | 4 | 420 |
| Limestone | 35 | 455 |
| Shale | 24 | 479 |
| Coal | 3 | 482 |
| Shale | 30 | 512 |
| Limestone | 12 | 524 |
| Shale | 23 | 547 |
| Sandstone | 24 | 571 |
| Shale | 26 | 597 |
| Sandstone (salt water) | 43 | 640 |
| Shale | 12 | 652 |
| Sandstone (salt water) | 55 | 707 |
| Shale | 8 | 715 |
| Sandstone (salt water) | 34 | 749 |
| Shale | 20 | 769 |
| Sandstone | 12 | 781 |
| Limestone | 8 | 789 |
| Sandstone and shale | 18 | 807 |
| Shale | 12 | 819 |
| Sandstone (salt water) | 10 | 829 |
| Shale | 4 | 833 |
| Limestone | 44 | 877 |
| Red rock | 3 | 880 |
| Shale | 5 | 885 |
| Limestone | 20 | 905 |
| Shale | 26 | 931 |
| Red rock | 10 | 941 |
| Shale | 20 | 961 |
| Limestone | 25 | 986 |
| Shale | 14 | 1,000 |
| Sandstone | 10 | 1,010 |

*Well No. 1 on Holthaus farm*—Concluded.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Shale | 12 | 1,022 |
| Sandstone (salt water) | 38 | 1,060 |
| Shale | 12 | 1,072 |
| Limestone | 8 | 1,080 |
| Shale | 20 | 1,106 |
| Limestone | 8 | 1,108 |
| Shale | 6 | 1,114 |
| Red rock | 4 | 1,118 |
| Limestone | 12 | 1,130 |
| Red rock | 15 | 1,145 |
| Sandstone (salt water) | 20 | 1,165 |
| Shale | 5 | 1,170 |
| Sandstone (salt water) | 50 | 1,220 |
| Shale | 5 | 1,225 |
| Limestone | 10 | 1,235 |
| Sandstone (salt water) | 53 | 1,288 |

*Well No. 2 on A. Beckemeyer farm.*

Location—N. E. ¼ N. W. ¼ sec. 22, T. 2 N., R. 3 W.
Altitude—455 feet.

| | Thickness —feet. | Depth —feet. |
|---|---|---|
| Soil | 5 | 5 |
| Sand and gravel | 50 | 55 |
| Limestone | 15 | 70 |
| "Slate" | 70 | 140 |
| Limestone | 10 | 150 |
| Shale | 150 | 300 |
| Limestone | 8 | 308 |
| "Slate" | 67 | 375 |
| Shale | 60 | 435 |
| "Slate" | 4 | 439 |
| Coal | 6 | 445 |
| Clay | 10 | 455 |
| "Slate" | 165 | 620 |
| Sandstone (salt water) | 10 | 630 |
| "Slate" | 60 | 690 |
| Sandstone (salt water) | 90 | 780 |
| Shale | 20 | 800 |
| Sandstone | 20 | 820 |
| Shale | 5 | 825 |
| Sandstone | 10 | 835 |
| Limestone | 30 | 865 |
| Sandstone (salt water) | 35 | 900 |
| Shale | 10 | 910 |
| Limestone | 10 | 920 |
| Shale | 20 | 940 |
| Limestone | 15 | 955 |
| Shale | 5 | 960 |
| Limestone | 35 | 995 |
| Shale | 15 | 1,010 |
| Limestone | 18 | 1,028 |
| Sandstone (salt water) | 51 | 1,079 |
| Shale | 5 | 1,084 |

# THE CARLINVILLE OIL AND GAS FIELD.

## TABLE OF CONTENTS.



## LIST OF ILLUSTRATIONS.

### Plates.

# THE CARLINVILLE OIL AND GAS FIELD.

(By Fred H. Kay.)

## INTRODUCTION.

This paper is a preliminary report on the Carlinville oil and gas field, and is designed to meet the needs of operators who are attempting to locate the most favorable areas for the accumulation of oil and gas. Data are too meagre at the present time for the deduction of final conclusions regarding the possibilities of the field, but it is hoped that this presentation of available information will be of some use in pointing out the geologic structure of the field, and thereby limiting prudent exploration to the most favorable localities.

Acknowledgements are due to the operators who have freely submitted information regarding their wells, and especially to Mr. Thomas Rinaker for hearty cooperation, and for the use of a large number of data in his possession.

This report is an amplification of one made by Mr. R. S. Blatchley in Bulletin 16 of the State Geological Survey, 1910, and is based on more recent data than were available when Mr. Blatchley made his investigation of this field.

## LOCATION AND EXTENT.

The Carlinville oil and gas field is near Carlinville, Macoupin county, Illinois. Up to December 1, 1911, twenty-five wells had been drilled within a radius of five miles from town. The productive area, however, is three miles southwest of Carlinville in sections 7 and 8, T. 9 N., R. 7 W., as shown by Plate VIII.

The recent discovery of a commercial quantity of oil in addition to the gas for which the field has heretofore been known has stimulated interest, and has encouraged operators to undertake further prospecting.

Not enough drilling has been done to outline the productive field, but the principal wells lie in an elliptical area, the main axis of which is about one mile in length, extending from the central-eastern part of section 7, northeast into section 8. The minor or north-south axis is about one-quarter mile in length, drilling having been confined to the flood plain of Macoupin creek.

## HISTORY.

The first drilling in this field was done about 1867 by St. Louis capital. One well was put down without striking oil and was abandoned. No further efforts were made until 1909, when the Impromptu Exploration Company drilled several wells and developed enough gas for illuminating purposes in the town of Carlinville.

Although most of the drilling has been done by the Impromptu Exploration Company, the following operators have put down one or more holes: E. E. Chrysler; C. J. Lumpkin and associates; John Dunn; Andrew Benson; Ohio Consolidated Oil Co.; E. A. Ibbetson.

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## TOPOGRAPHY.

### Relief.

The Carlinville area is one of moderate relief. The upland prairies are level or gently rolling, and in most cases are less than 100 feet above the valley floors of the larger streams. The topography becomes rugged near the valleys of the principal drainage lines, and although the relief is not great, it is sufficient to characterize the wooded hills bordering the valleys as the "broken country."

No precise levels have been run in this district by the Survey and for the present report, Carlinville is considered to be 664 feet above sea level, this being the elevation given by the Chicago & Alton Railroad for their station.

### Drainage.

The main drainage line is Macoupin creek, which flows southwest through the district. This creek and its tributaries have cut valleys about 100 feet below the general level of the country, and the main flood plain, upon which most of the drilling has been done, is wide enough to be a conspicuous feature of the topography. At times of high water a large area bordering Macoupin creek is submerged, and sometimes, especially in the spring, surface water covers the casings and fills the wells. Run-off is rapid, however, and drilling operations are not often interrupted for any considerable time.

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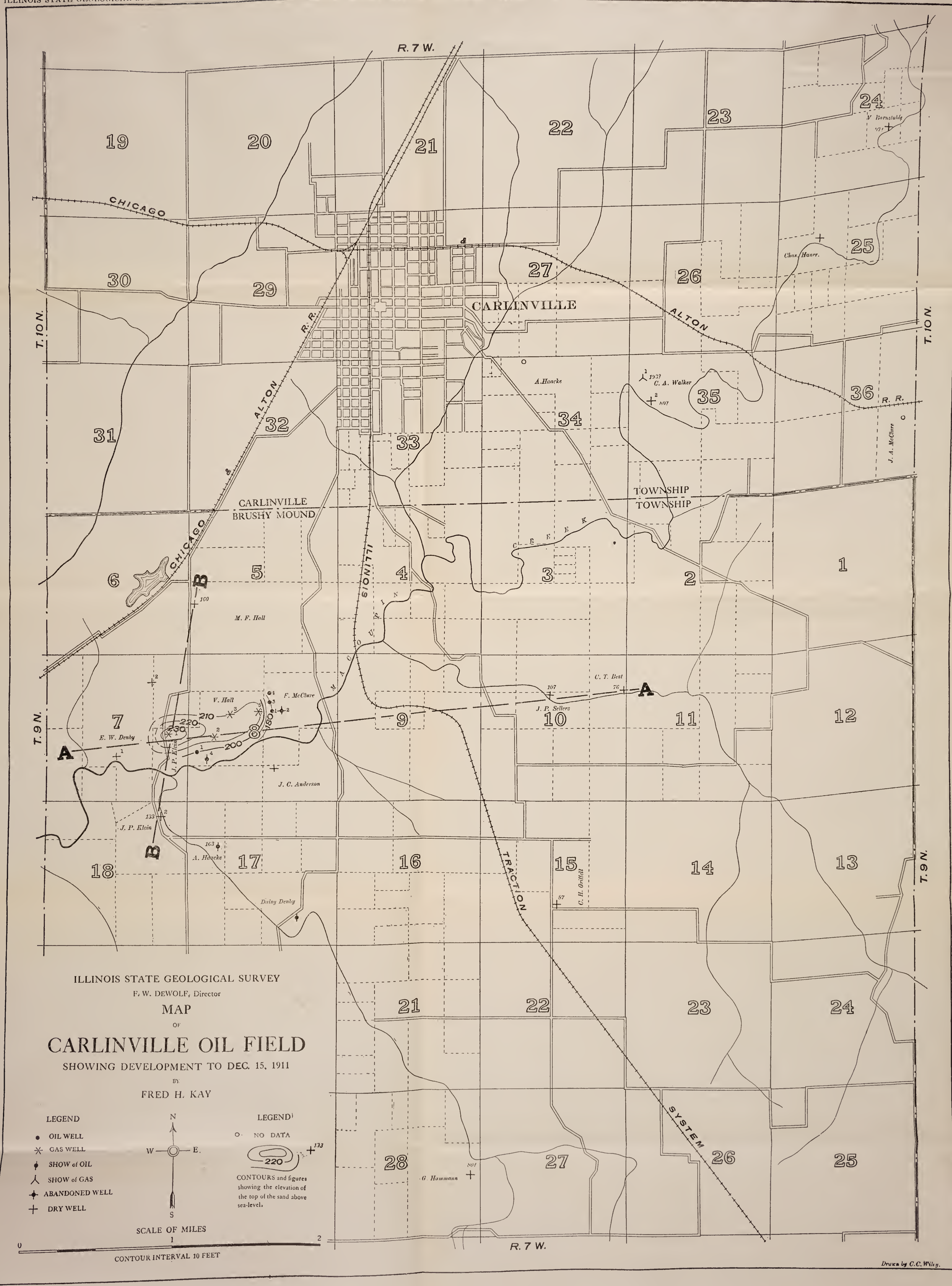
## GEOLOGY.

### Stratigraphy.

#### glacial drift.

Most of the bed-rock in the Carlinville field is covered by a variable amount of clays, sands, and gravels which constitute the glacial drift. The thickness of this material varies in different parts of Macoupin county, from a thin covering, up to 200 feet; the irregularity being


R. 7 W.
T. 10 N.
T. 9 N.
CARLINVILLE
CHICAGO & ALTON R.R.
ILLINOIS TRACTION SYSTEM
MACOUPIN CREEK
CARLINVILLE TOWNSHIP
BRUSHY MOUND TOWNSHIP
A
B
E. W. Denby
V. Hall
F. McClure
J. P. Klein
J. C. Anderson
M. F. Hall
A. Haacke
C. A. Walker
Chas. Hauer.
J. A. McClure
C. T. Best
J. P. Sellers
C. H. Grellat
Daisy Denby
G. Hammann
ILLINOIS STATE GEOLOGICAL SURVEY
F. W. DEWOLF, Director
MAP
OF
CARLINVILLE OIL FIELD
SHOWING DEVELOPMENT TO DEC. 15, 1911
BY
FRED H. KAY
LEGEND
OIL WELL
GAS WELL
SHOW of OIL
SHOW of GAS
ABANDONED WELL
DRY WELL
NO DATA
CONTOURS and figures showing the elevation of the top of the sand above sea-level.
SCALE OF MILES
CONTOUR INTERVAL 10 FEET
Drawn by C. C. Wiley.

due to the uneven character of the surface upon which the drift was deposited. The extreme thicknesses, such as those of 200 feet, are probably the result of the filling of pre-glacial valleys. Macoupin creek and its tributaries have carried away much of the surface material along their channels, and in some places have exposed the underlying rocks.

### "COAL MEASURES" ROCKS.

All of the stratified rocks exposed in the Carlinville field belong to the series known as the "Coal Measures." Although the series as a whole may be described as consisting of shales, sandstones, a minor amount of limestone and several beds of coal, it is usually impossible to correlate individual beds in different well logs with any degree of exactness. Three horizons—the Carlinville limestone, coal No. 6, and the oil and gas zone at the base—are persistent, but the intervening shales, although constant in thickness, are changeable in character.

The rocks above the oil sands in the Carlinville field have been divided by geologists into two parts, the name McLeansboro being assigned to the beds from the first solid rock near the surface, down to the top of coal No. 6. The beds above the oil sands up to and including coal No. 6 are known as the Carbondale formation.

The Carbondale varies in thickness from 200 to 250 feet; and since the McLeansboro was subject to erosion in pre-glacial times, its thickness is even more variable. Best No. 1 and Sellers No. 1 showed 200 feet of this formation, but the average for the field is lower. Barnstable No. 1 penetrated 550 feet of "Coal Measures" rocks. This figure is from 50 to 100 feet in excess of that for a majority of the wells in the Carlinville field. The following section gives a general idea of the position and thickness of the upper part of the "Coal Measures" strata.[1]

*Record of Weir's shaft, Carlinville.*

| | Depth to top—feet. | Thickness.—feet. | Depth to bottom—feet. |
|---|---|---|---|
| Drift clays | ............ | 75 | 75 |
| Shale, soft | 75 | 28½ | 103½ |
| Coal, soft | 103½ | ½ | 104 |
| Fire clays, dark and light | 104 | 5 | 109 |
| Sandstone and shale | 109 | 70 | 179 |
| Clay shale | 179 | 15 | 194 |
| Shale, dark | 194 | 6 | 200 |
| Coal, soft, smutty | 200 | 5 | 205 |
| Fire clay | 205 | 6 | 211 |
| Sandstone | 211 | 8½ | 219½ |
| Clay shale | 219½ | 2 | 221½ |
| Limestone | 221½ | 3 | 224½ |
| Clay shale | 224½ | 1 | 225½ |
| Limestone | 225½ | 1½ | 227 |
| Coal | 227 | 1½ | 228½ |
| Shale | 228½ | 6½ | 235 |
| Coal | 235 | ½ | 235½ |
| Fire clay | 235½ | 2½ | 238 |
| Hard rock (probably limestone or limey sandstone) | 238 | 12 | 250 |
| Shale | 250 | 5 | 255 |
| Limestone | 255 | 5 | 260 |
| Shale, black | 260 | 4 | 264 |
| Coal, No. 6 | 264 | 6 | 270 |

[1] Worthen, A. H., Geol. Survey, Illinois, Vol. V, 1873, p. 289.

*Carlinville limestone.*—No. 11 of the section is a seven-foot bed of hard, gray limestone known as the Carlinville. This limestone, which is frequently exposed, and which forms the bed rock in most of the field, has been traced from the vicinity of LaSalle, Ill., south to Carlinville, thence southeast into Saline county. Because of its occurrence over this large area, it constitutes a useful key horizon in any attempt to determine the structural geology of the field. Its absence in some of the wells is due, no doubt, to erosion prior to the deposition of the glacial material.

The following detailed sections of the Carlinville limestone are taken from a report by Mr. J. A. Udden.[1]

*Exposures on the Walker farm NE. 1-2 sec. 35, T. 10 N., R. 7 W.*

| | | Feet. |
|---|---|---|
| 3. | Limestone, chocolate colored, coarse grained in beds ½ to 6 inches in thickness | 3½ |
| 2. | Shales, gray | 10 |
| 1. | Limestone, very hard, bluish gray, in seams varying from 3, 8, to 12 inches; brown on weathering | 2 |

In the NW. ¼ sec. 31, T. 10 N., R. 7 W., the same limestone as bed No. 1 of the section given above, occurs with a thickness of 6 feet. It is exposed on the east side of Spanish Needles creek in the NW. ¼, sec. 21, T. 9 N., R. 7 W., and in a small tributary to this creek in the NW. ¼ sec. T. 9 N., R. 7 W. It outcrops at a few places in the channel of Macoupin creek. Mr. Udden says: "The Carlinville limestone averages about seven feet in thickness. It is generally buish gray, compact, close textured and very hard, breaking into irregular pieces. On weathering it assumes a rusty color. Two features are characteristic of this limestone, one, a blotchy appearance and the other its tendency to weather into seams two and one-half to three inches in thickness." About 15 feet above the Carlinville limestone and overlying gray shales, a 4-foot bed of coarse-grained, chocolate-colored limestone occurs, which, in some places, has the appearance of a sandstone because of the presence of sand grains and flakes of mica. This limestone disintegrates easily, and can usually be distinguished without difficulty from the harder Carlinville bed.

*Coal No. 6.*—Although several coal horizons are usually penetrated by the drill, only No. 6 holds its thickness and general characteristics over a considerable area. This coal, which averages about 6½ feet in thickness, occurs 200 to 220 feet below the Carlinville limestone. Some of the wells, such as Klein No. 1, V. Hall No. 5, McClure No. 1, and M. F. Hall No. 1, show no coal. It is possible that in some cases black shale represents the coal horizons, but it is most probable that the absence of coal is due to erosion prior to the deposition of the glacial drift.

The sands vary in thickness from a few feet to about seventy feet and are believed to constitute the Pottsville formation, lying at the base of the coal measures.

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[1] Udden, J. A., The Shoal Creek limestone, Bull. Geol. Survey, Illinois, No. 8, 1907, p. 120.

## MISSISSIPPIAN ROCKS.

Underneath the sands, the drill usually strikes limestone which is supposed to be either Ste. Genevieve or St. Louis limestone of Mississippian age, although no samples of this formation have been examined. The Chester shales, sandstones, and limestones, which underlie the State south of Carlinville, and which include most of the producing sands of the main oil fields, are absent in this field. This signifies that while the Chester beds were being deposited to the south, the Carlinville area was a land surface, subject to erosion. The fact that the Pottsville beds were afterward deposited upon an uneven surface, accounts for some of the irregularities in the thickness of the sands. The log of F. Hall No. 1 in the W. ½ SW. ¼, sec. 5, T. 9 N., R. 7 W., furnishes the deepest record in the field and is published herewith:

*Record of F. Hall well, No. 1.*

Location—W. ½ S. W. ¼ sec. 5, T. 9 N., R. 7 W.
Elevation—655 feet above sea level.

| | Depth to top—feet. | Thickness—feet. | Depth to bottom—feet. |
|---|---|---|---|
| Surface | ............ | 40 | 40 |
| Soapstone | 40 | 38 | 78 |
| Slate | 78 | 137 | 215 |
| Limestone, white | 215 | 8 | 223 |
| Shale, black and coal | 223 | 10 | 233 |
| Lime shell | 233 | 4 | 237 |
| Slate, white | 237 | 6 | 243 |
| Lime | 243 | 8 | 251 |
| Slate, white | 251 | 39 | 290 |
| Coal | 290 | 3 | 293 |
| Slate, white | 293 | 57 | 350 |
| Shale, brown | 350 | 8 | 358 |
| Slate, white, sandy | 358 | 137 | 495 |
| Sand, coarse (gas?) | 495 | 10 | 505 |
| Sand, soft, salt water | 505 | 65 | 570 |
| Lime, sandy, hard (fresh water at 700) | 570 | 156 | 726 |
| Sand, salt | 726 | 5 | 731 |
| Limestone, hard | 731 | 24 | 755 |
| Water sand | 755 | 20 | 775 |
| Limestone | 775 | 25 | 800 |
| Limestone and shale | 800 | 13 | 813 |
| Limestone and sand | 813 | 25 | 838 |
| Limestone, broken | 838 | 32 | 870 |
| Limestone, brown | 870 | 15 | 885 |
| Limestone, black (iron pyrites) | 885 | 10 | 895 |
| Sand, gray | 895 | 25 | 920 |
| Shale | 920 | 48 | 968 |
| Limestone, sandy (salt water) | 968 | 247 | 1,215 |
| Limestone, red and brown | 1,215 | 10 | 1,225 |
| Limestone, gray | 1,225 | 25 | 1,250 |
| Slate, light colored | 1,250 | 50 | 1,300 |
| Limestone, brown | 1,300 | 8 | 1,308 |
| Slate, black, gritty | 1,308 | 87 | 1,395 |
| Limestone | 1,395 | 160 | 1,555 |
| Sandstone | 1,555 | 45 | 1,600 |
| Unrecorded | 1,600 | 135 | 1,735 |
| Slate, white | 1,735 | 179 | 1,914 |
| Lime (water almost fresh) | 1,914 | 193 | 2,107 |

### Structure.

Since most of the rocks are covered by a mantle of glacial drift, the arrangement of the beds and the "lay" of the sands must be determined by a study of the well logs. The map which accompanies this report (Plate VIII) shows contour lines drawn with a ten-foot interval, connecting those points on the top of the oil sands which have the same elevations above sea level. The elevations of the wells were determined by stadia surveys and the altitude of the oil sands were obtained by subtracting from the well elevation, the amount of material above the sands, as shown by the well logs.

The present wells roughly outline a fold of considerable intensity but of small areal extent. The apex or highest point is probably reached by Klein No. 1, located in the NE. ½, SE. ¼ sec. 7. In it the sand occurs 238 feet above sea level, or more than 100 feet higher than the corresponding sands in Klein No. 2, which is but one-half mile south. The general shape of the fold resembles the bowl of an inverted spoon, its longest axis extending about N. 60° E. from the center of the eastern half of sec. 7, T. 9 N., R. 7 W.

Plates IX and X indicate the dips along lines A-A and B-B of Plate VIII. From Klein No. 1, the strata dip steeply to the north, west and south, but more gently to the east. In Hall No. 5, near the center of sec. 8, the productive sands are found only 24 feet lower than those in Klein No. 1. East of Hall No. 5 the sands show a dip of 34 feet to McClure No. 1, which is 600 feet distant. No accurate information is available for the territory east of the McClure wells, except the logs of Sellers No. 1 in the SE. ¼, NW. ¼ sec. 10, and Best No. 1, in the NE. ¼ sec. 10. In the former, the sands were found at 107 feet above sea level, and in the latter, at 76 feet; thus showing a continuation of the general dip noted in the E. ½ sec. 8.

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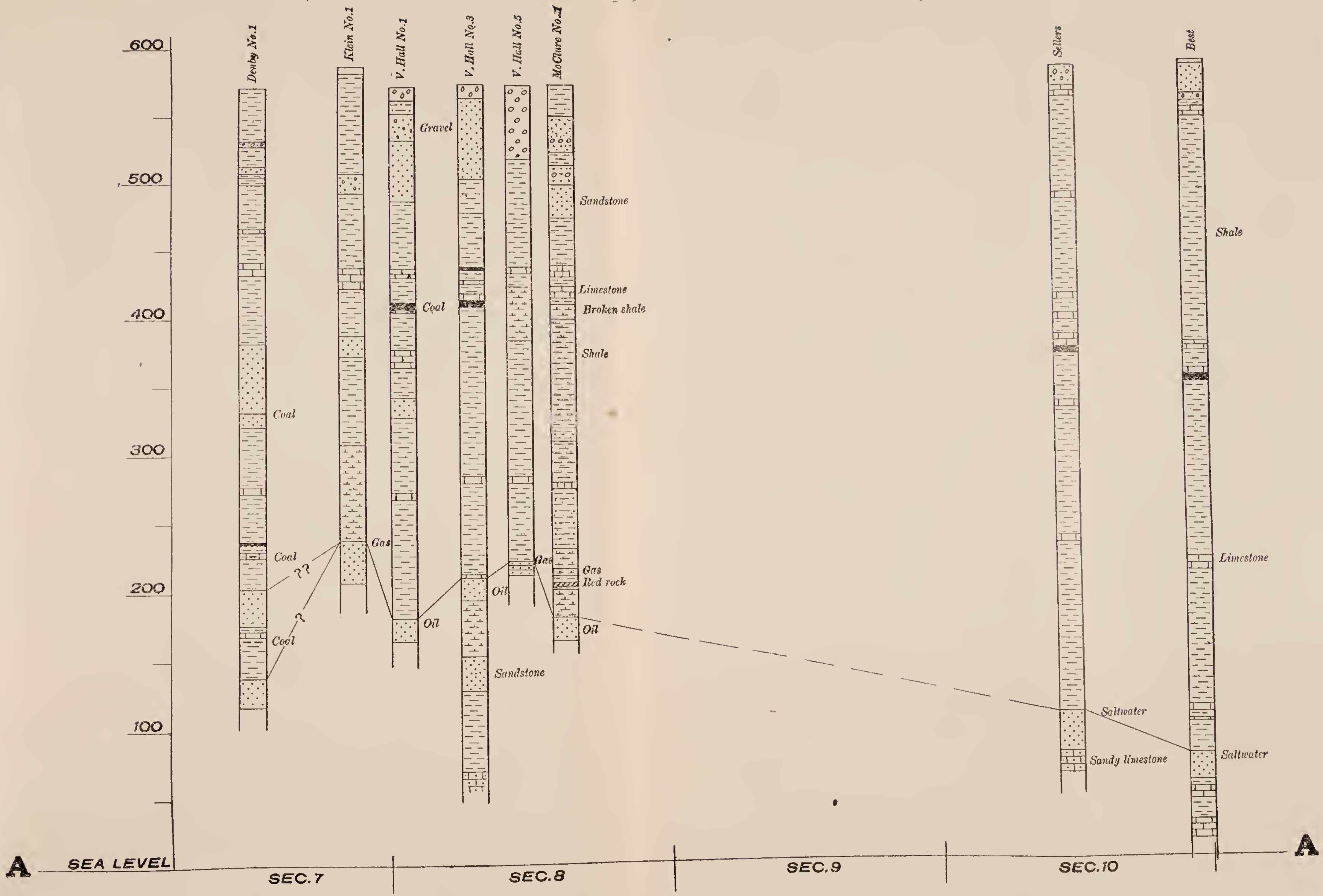
## OIL AND GAS.

### The Sands.

Although the productive sands are not invariably found at the same stratigraphic position, they lie near the base of the coal measures, and are believed to constitute the Pottsville formation.

A study of the well logs reveals the fact that no single sand is traceable throughout the field. Adjacent wells do not show the same stratigraphic succession, although in a general way the rocks consist of shale, sandstone, and minor amounts of limestone. Furthermore, the producing sands vary in thickness from 2 or 3 feet up to 70 feet, and this change occurs within comparatively short distances. In Klein No. 2 the sand is apparently absent, and in its place is a sandy shale which lacks sufficient porosity to permit the accumulation of oil.

In view of the irregularity in the development of the sands it seems best not to attempt the correlation of individual beds, but to consider




Structure section from west to east through Carlinville field.
(For location see Plate VIII.)

them as members of a series occurring in a zone about 70 feet thick and beginning about 200 feet below coal No. 6. The beds in this zone consist chiefly of coarse and fine sands, but the local thinning out of the sands is probably due to the fact that at the time of deposition the sediments were not clear sands, but a mixture of sands, muds, and silts. This mixture has resulted in the absence here and there of sands capable of acting as reservoirs for commercial amounts of oil and gas.

In many of the wells, the productive sand is separated into two parts by a "break" of variable thickness. In some cases, as in McClure No. 3, the "break" marks the boundary between the oil and gas.

The variability in the thickness of the productive sands is probably due, not so much to a change in the amount of sand, as to its change in character from place to place. Oil and gas naturally accumulate in the more porous parts of a sand, leaving the compact portions practically dry.

### Production.

Until November, 1911, the Carlinville wells were known chiefly for gas. V. Hall No. 1 produced from 4 to 5 barrels of oil daily, but this was not utilized to any extent. The gas wells showed an initial pressure of about 135 pounds, but the drain on the supply, together with the additional drilling in the gas area, has reduced the pressure to about 35 pounds.

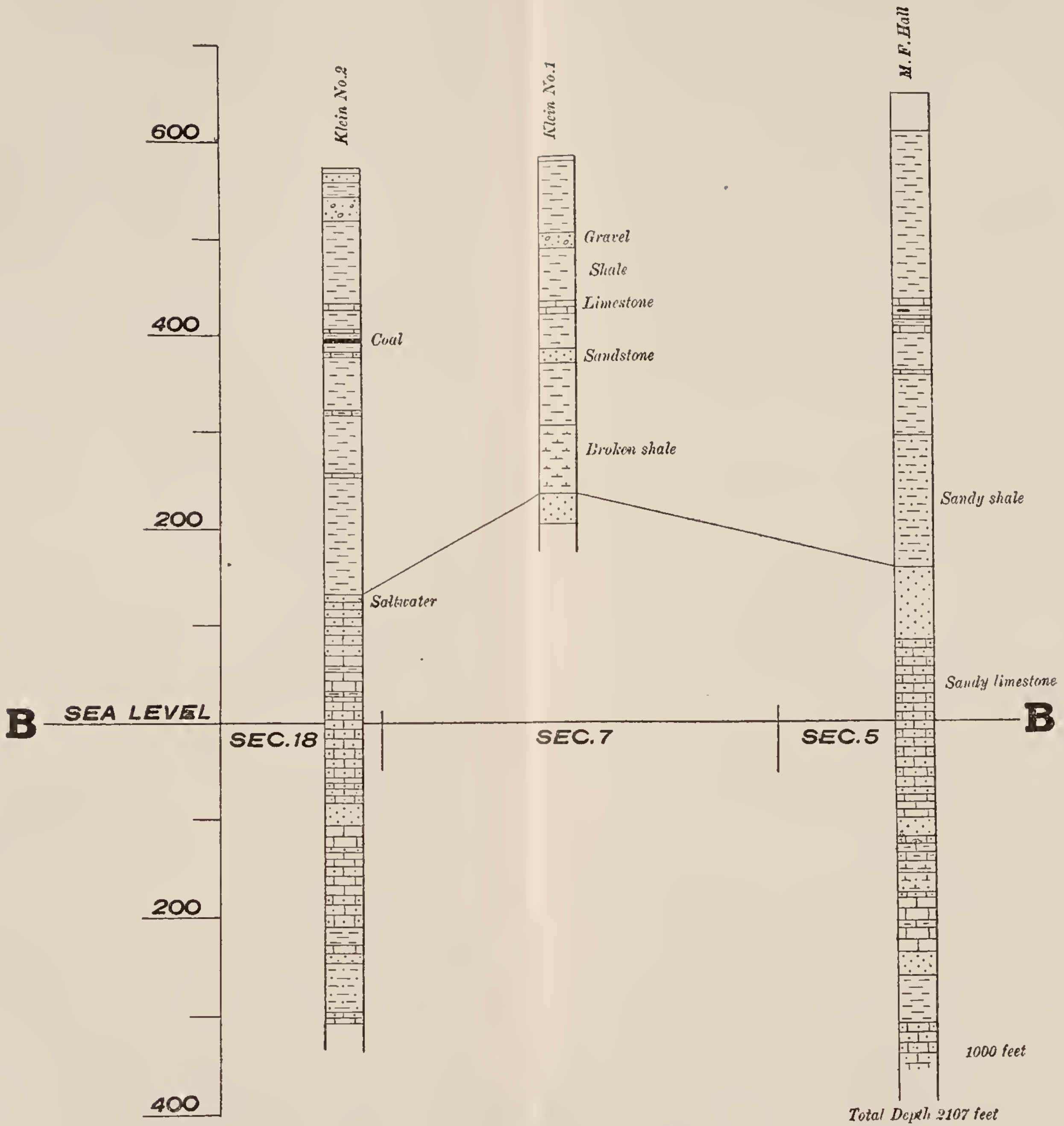
The production of the McClure oil wells in sec. 9, T. 9 N., R. 7 W., has not been determined accurately. None of the wells have been shot, and the drillers' estimates are based upon the showing while drilling in. It is probable that McClure Nos. 1 and 3 are capable of producing an average of 10 barrels daily.

### Development.

The following table shows the development in the Carlinville field, and contains well data gathered from various operators and drillers:

*Partial record of Carlinville wells.*

| Name. | Location. | Altitude. | Strata. | Depth to top—feet. | Thickness—feet. | Remarks. |
|---|---|---|---|---|---|---|
| Barnstable No. 1 | NE. ¼ SE. ¼ Sec. 7, T. 10 N., R. 7 W. | 610 | Salt sand | 547 | | Bottom 550. Rainbow of oil. Small amount gas in salt water at 547. |
| Walker No. 1 | NW. ¼ Sec. 35 | 590? | Coal | 208 | 7 | Bottom 447 |
| | | | ..do | 335 | 5 | |
| | | | Gas sand | 397 | 8 | |
| Walker No. 2 | NW. ¼ Sec. 35 | 590? | Coal | 220 | 5 | Bottom 535. No gas |
| | | | Salt sand | 510 | 15 | |
| F. Hall No. 1 | W. ½ SW. ¼ Sec. 5, T. 9 N., R. 7 W. | 655 | Coal | 290 | 3 | Bottom 2107 |
| | | | Sand, coarse | 495 | 10 | |
| | | | Salt sand | 505 | 65 | |
| E. W. Denby No. 1 | NE. ¼ SW. ¼ Sec. 7 | 572 | Coal | 160 | Streak | Bottom 455. Little gas at 160 |
| | | | Coal | 241 | Streak | |
| | | | Coal | 335 | 2 feet | |
| | | | Coal | 404 | Streak | |
| | | | Salt sand | 369 | 27 | |
| | | | Salt sand | 434 | 21 | |
| | | | Carlinville lime | 130 | | |
| Klein No. 1 | NE. ¼ SE. ¼ Sec. 7 | 588 | Gas sand | 350 | 31 | Bottom 381. Initial pressure 135 pounds. |
| Klein No. 2 | E. ½ NE. ¼ Sec. 18 | 573 | Coal | 175 | 5 | Bottom 880 in limestone. Salt water at 450 charged with gas. |
| | | | Sand and salt water | 465 | 38 | |
| V. Hall No. 1 | NW. ¼ S. W. ¼ Sec. 8 | 572 | Coal | 160 | 5 | Bottom 409 in 17 feet sand. Gas in shale at 373. Oil at 388. Average 4 bbls |
| V. Hall No. 3 | SE. ¼ NW. ¼ Sec. 8 | 574 | Coal | 135 | 3 | Bottom in sandy lime at 506 |
| | | | Coal | 160 | 5 | |
| | | | Gas sand | 364 | 7 | |
| | | | Water sand | 371 | 10 | |
| | | | Oil sand | 376 | 5 | |
| V. Hall No. 5 | SE. ¼ NW. ¼ Sec. 8 | 574 | Sand, show of oil | 353 | 2 | Bottom 363. Fine water sand. Salt water and rainbow of oil |
| | | | Sand, brown | 355½ | 4 | |
| | | | Sand fine, gas | 359½ | 3 | |
| McClure No. 1 | SW. ¼ NE. ¼ Sec. 8 | 574 | Oil sand | 394 | 16+ | Bottom 410. Good pay. Estimated 10-15 bbls. No salt water |
| McClure No. 2 | SW. ¼ NE. ¼ Sec. 8 | 574 | Gas sand | 373 | 3 | Abandoned at 376. Crooked hole |
| | | | Shale gas | 347 | | |
| McClure No. 3 | SW. ¼ NE. ¼ Sec. 8 | 574 | Gas sand | 377 | 13 | Bottom 412. Sand with small amount salt water. Estimated 10-15 bbls |
| | | | Slate | 390 | 4 | |
| | | | Oil sand | 394 | 16 | |
| McClure No. 4 | SW. ¼ NE. ¼ Sec. 8 | 576 | Gas sand | 350 | 10 | Bottom 419. Sand broken. Small amount oil and gas. Best show 405-410 |
| | | | Gas sand | 378 | 11 | |
| | | | Oil sand | 405 | 11 | |




Structure section from south to north through Carlinville field.
(For location see Plate VIII.)

| | | | | | | |
|---|---|---|---|---|---|---|
| Sellers No. 1 | SE. ¼ NW. ¼ Sec. 10 | 587 | Coal | 210 | 5 | Bottom 525 |
| | | | Salt sand | 480 | 29 | |
| | | | Carlinville lime | 15 | | |
| Best No. 1 | NE. ¼ NE. ¼ Sec. 10 | 591 | Coal | 240 | 5 | Bottom 578. Show of oil 516 |
| | | | Salt sand | 515 | 20 | |
| | | | Carlinville lime | 35 | | |
| Haacke No. 1 | SW. ¼ NW. ¼ Sec. 17 | 577 | Coal | 172 | 5 | Bottom in sand at 450. Show of oil in black slate 392-410. Oil 417 (small amount.) Salt water 421. |
| | | | Sand | 389 | 61 | |
| D. Denby No. 1 | SW. ¼ SE. ¼ Sec. 17 | 585 | Coal | 395 | 3 | Bottom 536. Dry |
| | | | Sand, show oil | 417 | 5 | |
| | | | Sand, white and blue | 422 | 7½ | |
| | | | Salt water in sand | 465 | 50 | |
| Griffell No. 1 | NW. ¼ SE. ¼ Sec. 15 | 718 | Coal | 365 | 5 | Bottom in lime 655 |
| | | | Sand, salt water | 631 | 12 | |
| Hammann No. 1 | NE. ¼ SE. ¼ Sec. 28 | 590? | Sand | 509 | 6+ | Bottom 515. Small amouut gas in upper part of sand |
| | | | Salt water | 515 | | |

## Character of Oil and Gas.

The gas is of good quality. It has little odor and burns with a hot blue flame. Mr. Rinaker reports that the gas in Klein No. 2 was noted only as it was liberated from the slightly brackish water bailed from the lower part of the well. When ignited at the top of the bailer, the gas burned with a faint bluish flame and with an odor resembling alcohol. The water, freed from the gas, settled as much as two feet in the bailer.

The oil is dark brown by transmitted light and nearly black by reflected light. Two samples from V. Hall No. 1 and McClure No. 3 have a specific gravity of 28.6° Baumé. The oil is similar in physical respects, to that at Duncanville, Illinois, which is utilized almost entirely as fuel.

## Relation of Oil and Gas to Structure.

It is generally assumed when oil and gas occur near the top of a dome, as at Carlinville, that they are held in position by the salt water below. If this were not true the oil would settle of its own weight into the lowest parts of the productive sand.

In case the oil is not sufficiently abundant to saturate the sands above the level of salt water, the gas occupies the crest of the dome above the oil. The latter, resting on the salt water below, holds an intermediate position and, in most cases, is charged with gas from above because of the great pressure exerted by the underlying water.

The Carlinville dome, although irregular in shape, appears to conform in general, to the ideal dome. The gas wells are located at or near the crest of the fold. Klein No. 1 in the E. ½, SE. ¼ sec. 7, T. 9 N., R. 7 W. reaches the sand at 238 feet above sea level. The sands in the V. Hall gas wells, sec. 8, although about 24 feet lower than in Klein No. 1, do not reach the level of the oil. In some cases, the gas sands are discolored and probably show the former presence of oil at a time when the salt water level was somewhat higher than at present. As the water level was lowered, the oil settled down dip by its own weight, and drained the upper part of the sands, leaving them discolored, perhaps, but with no free oil.

The gas accompanying brackish water in Klein No. 2 in the E. ½, NE. ¼ sec. 8, has been noted on a previous page. Its occurrence is exceptional. The water, charged with gas, was found in a sand at a depth of 450 feet, or 130 feet above sea level. Thus it occurs at a lower level than the bulk of the oil and gas in the field.

It is probable that a very small fold or flattening of the beds with steeper dips above and below, occurs in the vicinity of Klein No. 2. A small amount of oil and gas on its way upward to the top of the water-bearing sand did not reach the crest of the dome, but was trapped in the minor fold below. The pressure developed was probably sufficient to cause most of the gas to be dissolved in the water, where it was held until the pressure was relieved by the drilling of Klein No. 2.

The oil has come into prominence only recently. V. Hall No. 1 in the NW. ¼, SW. ¼, sec. 8 and McClure Nos. 1 and 3 in the SW. ¼, NE. ¼ sec. 8, are the only wells so placed that they penetrate the zone

of free oil. These wells are located down dip from the top of the dome, and all three reach oil at the same elevation above sea level. Up to the present time, no commercial amount of oil has been found in the Carlinville dome at a higher altitude than 184 feet above sea level. The lower limit of the oil sands and the areas considered most favorable for prospecting will be discussed under a later heading.

Since salt water immediately underlies the oil, any information regarding its position is of utmost importance. Somewhat unusual conditions obtain in the Carlinville dome. The oil sand has been found dry in the McClure wells at 162 feet above sea level. In V. Hall No. 5—600 feet west of McClure No. 1—troublesome salt water was reached at an elevation of 210 feet. V. Hall No. 4 shows salt water in the upper part of the dome.

It is almost certain that these higher bodies of salt water are not part of the general zone of saturation. It has been mentioned above that the sands are more or less irregular or lenticular. Since this is true, it is possible that certain lenses, surrounded by impervious beds, are capable of holding salt water at a higher level than would be possible if the sands were all of the same horizon and continuous.

Another explanation for the higher salt water in the V. Hall wells, attributes the "drowning" of the sands to the fact that no effort was made to shut out the water in the old well of 1867, which was located near the east quarter corner of section 7. So far as can be learned, this well was drilled deep enough to reach salt water and upon abandonment no attempt was made to protect the adjacent sands from "drowning." It is probable that for many years the salt water has percolated slowly down dip from the well and has affected a considerable territory in section 8.

The level of salt water in the neighborhood of the Carlinville dome is difficult to determine accurately from the available data. The log of Haacke No. 1 in the SW. ¼, NW. ¼, sec. 17, shows salt water at a depth of 421 feet or 156 feet above sea level. E. W. Denby No. 1 in the SE. corner, NE. ¼, sec. 7 reaches salt water at 427 feet, or 145 feet above sea level. F. Hall No. 1 in the NW. ¼, SW. ¼, sec. 5, T. 9 N., R. 7 W., taps the same horizon at a depth of 505 feet, or 150 feet above the sea.

On account of the uncertain thickness of the sands, great care must be exercised while drilling, in order not to tap the salt water after reaching "pay." In V. Hall No. 5, in the SE. ¼, NW. ¼, sec. 8, although the sand was penetrated only 9 feet, salt water was present on the day following the completion of the well and has continued to be very troublesome. McClure Nos. 1 and 3, end in sand only a few feet above the general level of salt water in the district, and any attempt at "shooting" would probably admit bottom water.

## Probable Extension of Field.

It is unwise and, in fact, impossible to predict with certainty, the presence of oil and gas in any given locality. The Carlinville field presents difficulties because of the marked irregularity in the thickness and character of the sand. However, after a careful study of all available data, it is possible to point out the areas in which the geological structure is most favorable for the accumulation of these materials.

It seems reasonable to expect oil at about the same level on all sides of the irregular dome at distances from the central gas area, varying inversely as the dip of the oil sands (See map, Plate VIII). Because of the steep dips on the west side, the productive area will probably be narrower than on the east and northeast where the strata dip more gently. Whether or not oil will be found in commercial quantities is a question which can be settled only by the drill. The crest of the Carlinville dome has been tested by Klein No. 1 in the E. ½, SE. ¼, sec. 7 and the V. Hall gas wells in the western part of section 8. Only V. Hall No. 1 and McClure Nos. 1 and 3 tap the body of oil which is believed to extend around the irregular elongated dome. The salt water wells that have been drilled north, west, and south of the productive area, together with the apparent rapid dip of the sands away from the dome, seem to signify that in the eastern part of section 7, and in the western part of section 8, the productive zone will be narrow, and the location of successful oil wells most difficult.

On the north side of the dome the E. ½, NW. ¼, sec. 8 seems to warrant testing. The V. Hall farm should be prospected by a well located on the south side of Macoupin creek near the east line of the property. The McClure farm, upon which considerable drilling is being done, lies along the main axis of the elongated dome, and contains the best oil wells developed in the field up to the present time.

While the attitude of the sands northeast of the productive area is uncertain, it is believed that the dip in this direction is more gentle than that of the beds west of the dome. If this is true the sands may contain oil for a considerable distance northeast of the present area before reaching the level of salt-water saturation. At any rate, further prospecting should be done in a general northeast direction from McClure Nos. 1 and 3.

It is hoped that in the near future, the State Geological Survey will be able to undertake further detailed investigations in Macoupin county, in an effort to locate other districts in which the structure is favorable for the accumulation of oil and gas.

The Survey is always glad to cooperate with oil men and to give them the benefit of any studies which may be made. To this end, it is necessary that detailed logs be kept by the driller with careful identification of the materials passed through with each screw. Any detailed information furnished by the operator will be held confidential if so desired.